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Imaizumi et al.

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(54) **OPTICAL CABLE CONNECTING CLOSURE AND OPTICAL INTERCONNECTION SYSTEM**

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G02B 6/28 (2006.01)
G02B 6/38 (2006.01)
G02B 6/26 (2006.01)

(52) **U.S. Cl.** **385/135**; 385/100; 385/53; 385/134; 385/24; 385/59; 385/27; 385/73

(58) **Field of Classification Search** 385/53, 385/92, 94, 88, 89, 134, 135, 136, 137, 138, 385/139, 100, 24, 59, 27, 73
See application file for complete search history.

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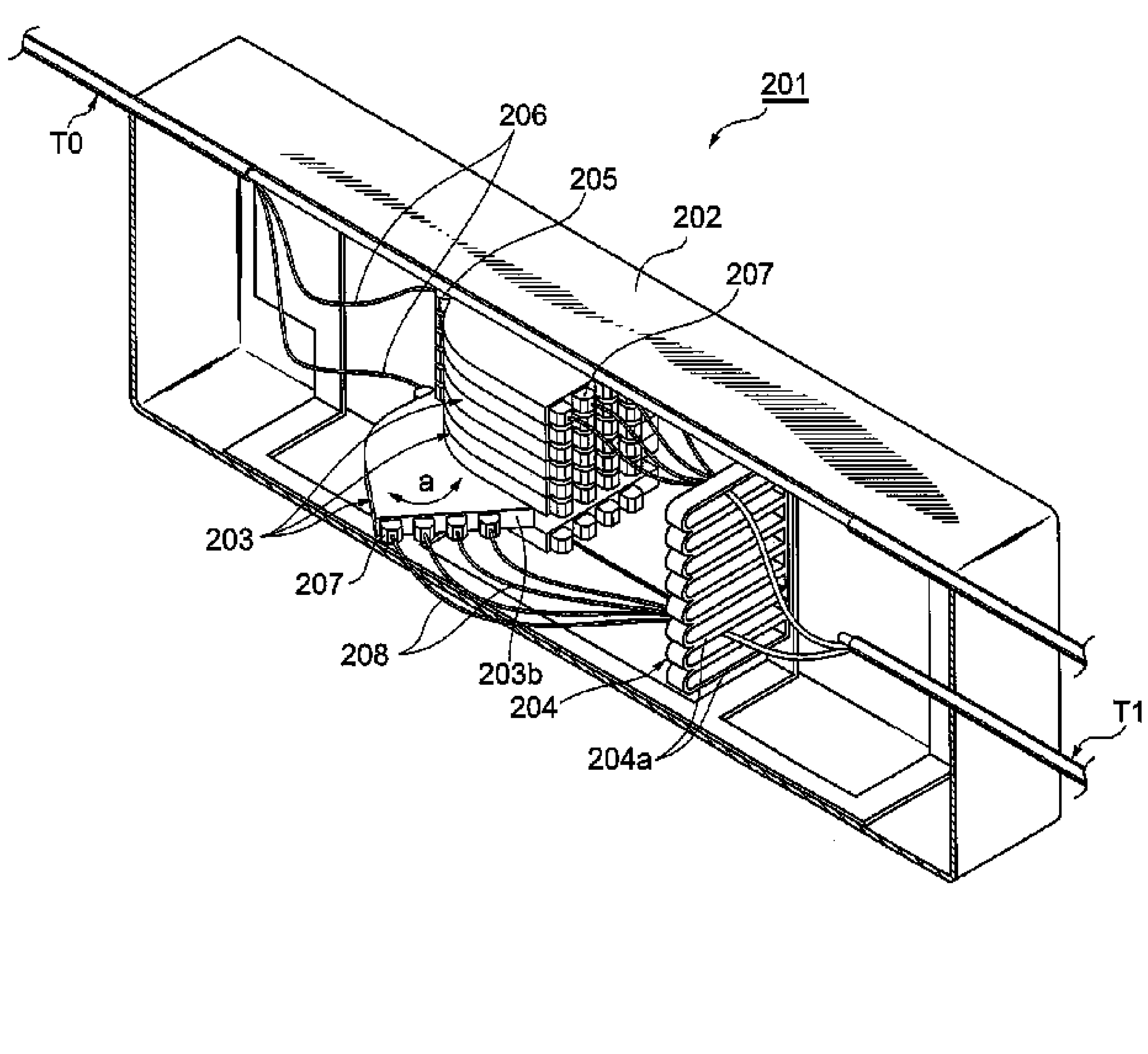
(57) **ABSTRACT**

[Problem] To provide an optical cable connecting closure and optical interconnection system which can easily respond to changes in required connection functions if any.
[Solving Means] An optical cable connecting closure **118** has a case **121**, while a plurality of connecting modules **123** are arranged (stored) so as to be erected with respect to the bottom face of a closure main body **119** along the width direction in a module storing section **122** of the case **121**. The connecting module **123** has a rectangular parallelepiped board-like module main body **127**, while a plurality of MT connectors **128**, **129** are attached in a vertical row to one end face of the module main body **127**. In the module main body **127**, an optical connecting section **130** for connecting the MT connectors **128**, **129** to each other is arranged. The module storing section **122** can store a different kind of connecting



module having a connecting configuration (function) different from that of the connecting module **123**.

11 Claims, 32 Drawing Sheets

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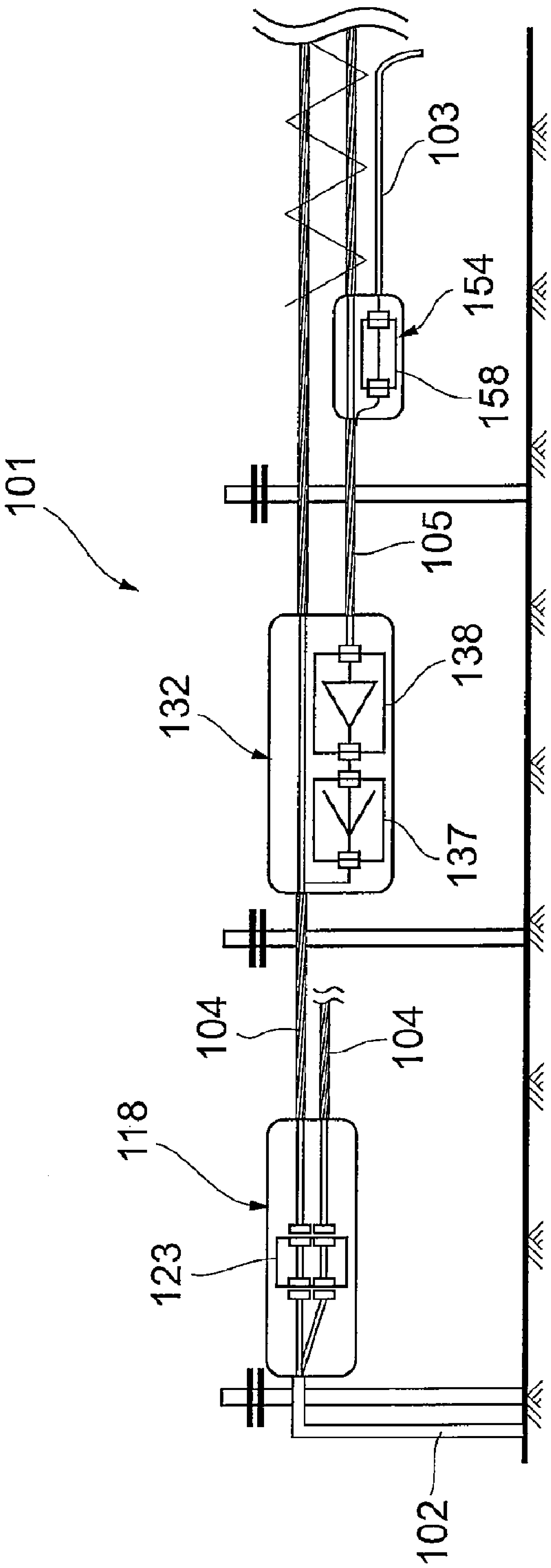

Fig.1

Fig.2

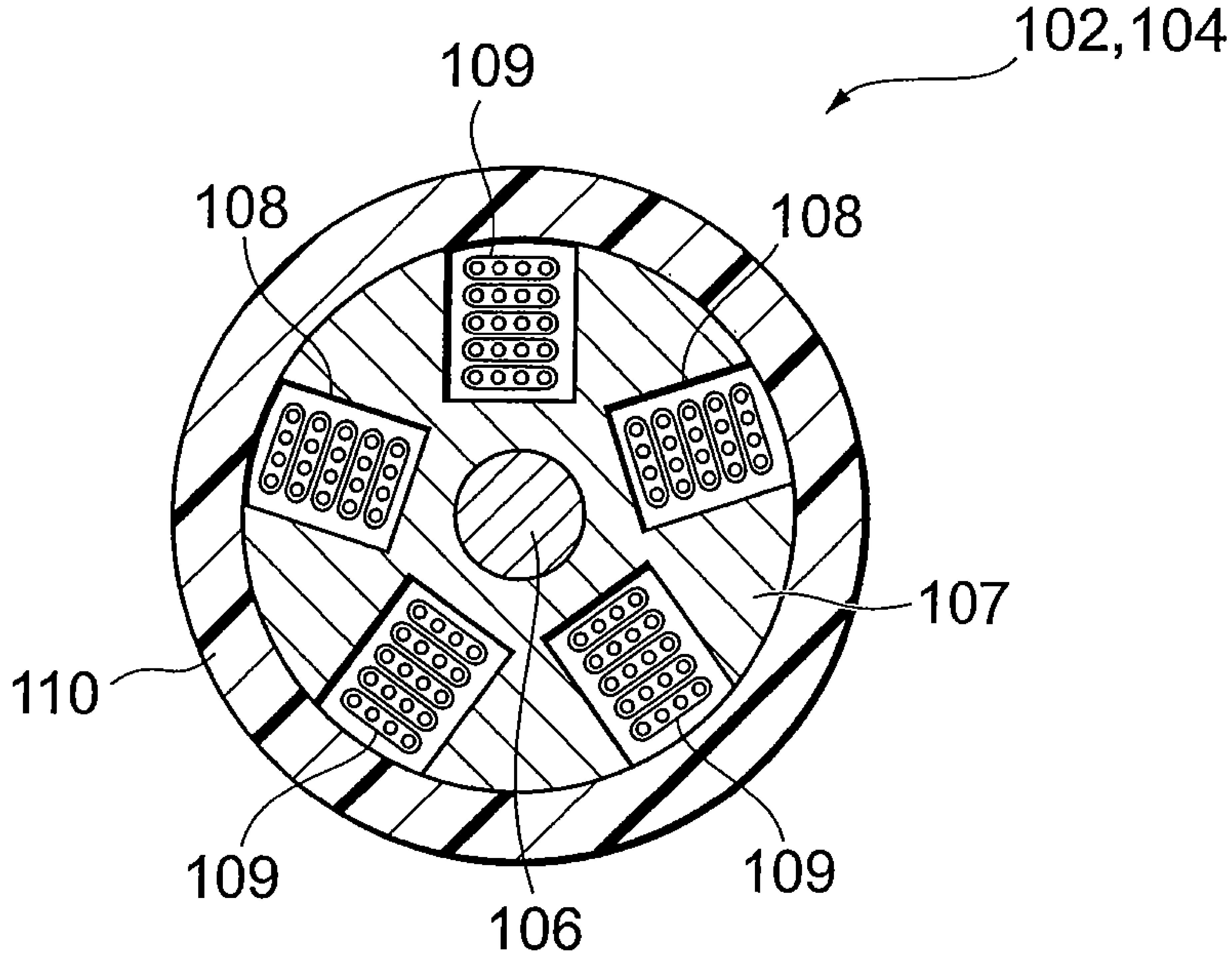

Fig.3

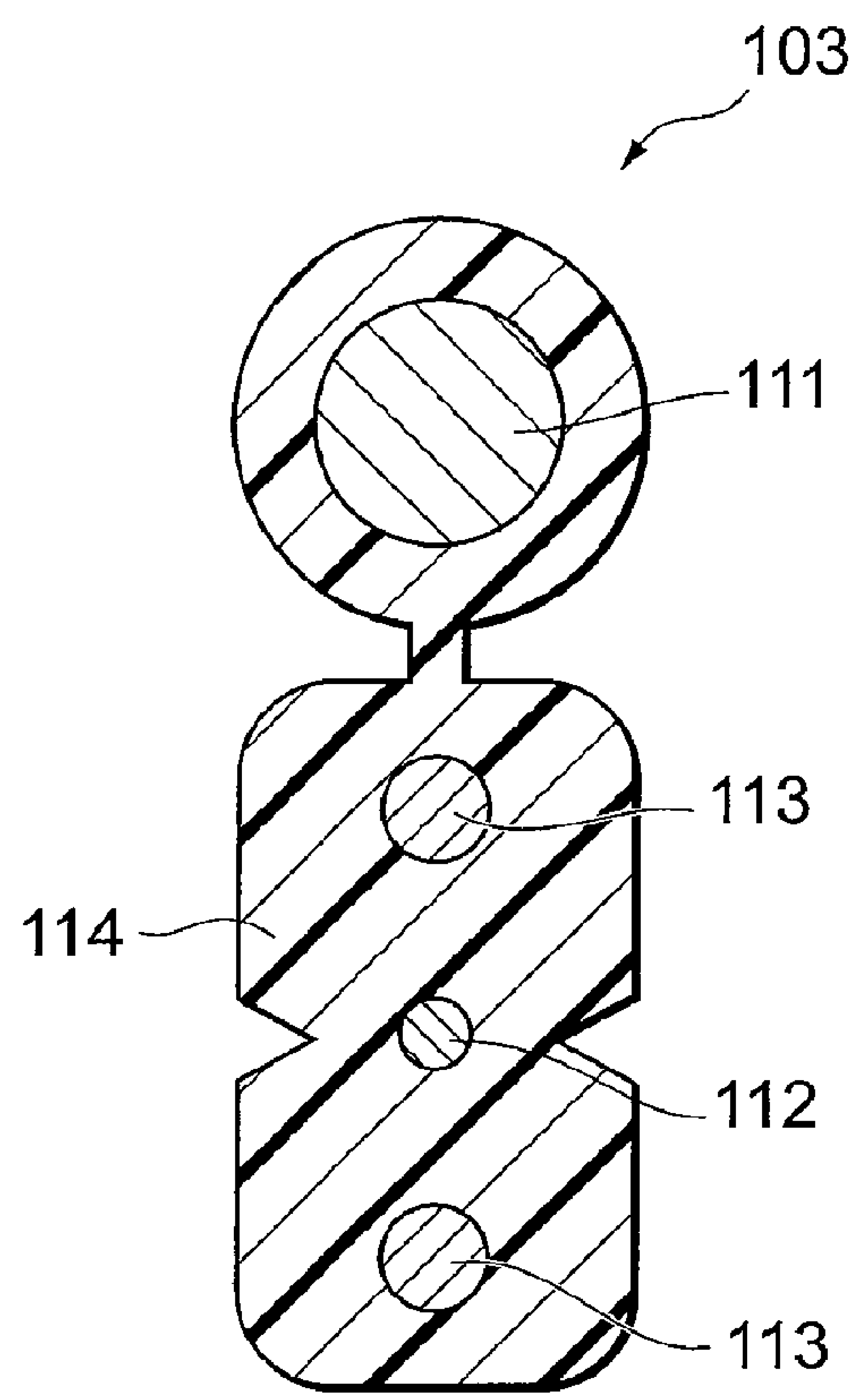

Fig.4

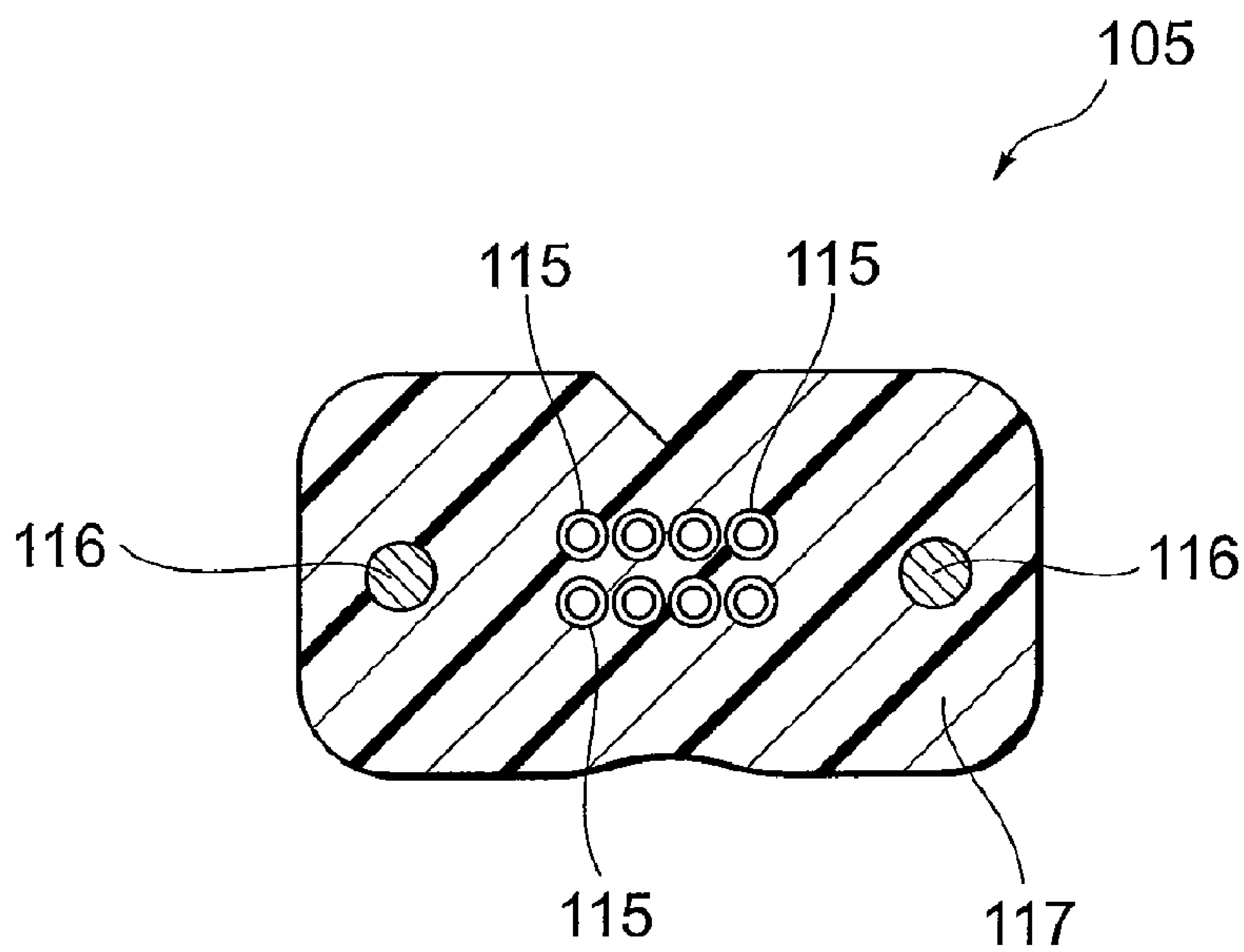

Fig.5

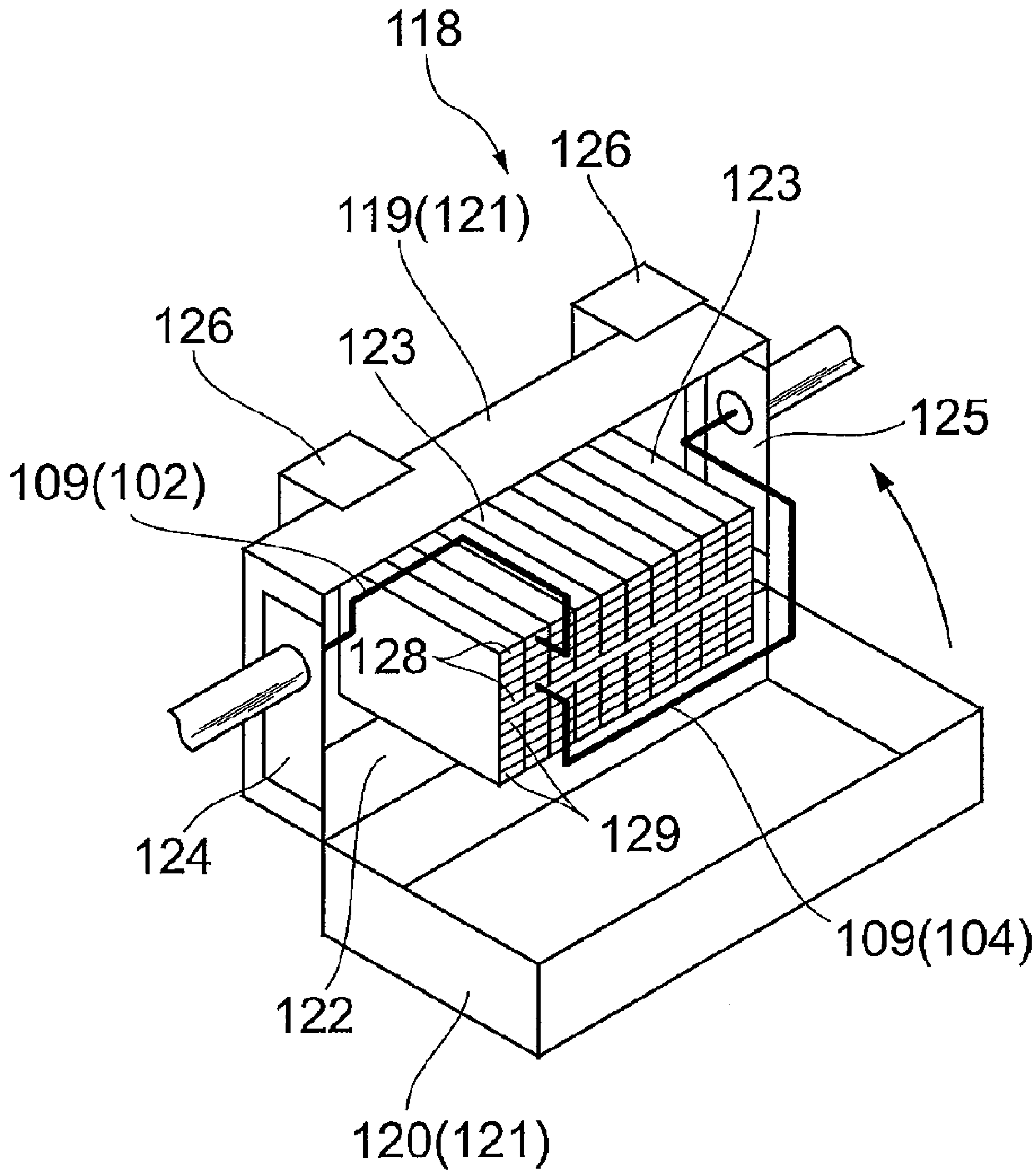
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Fig.6

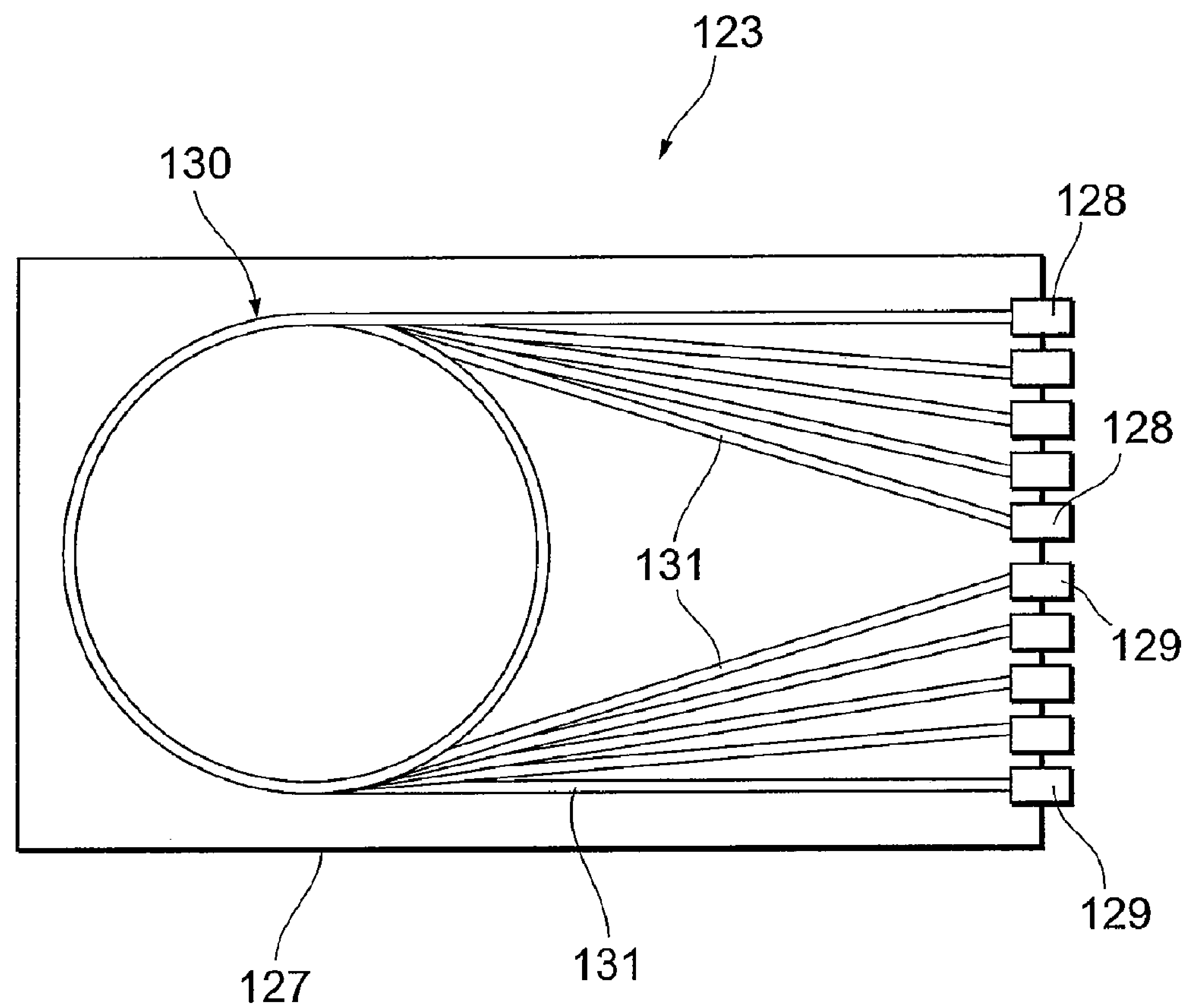

Fig.7

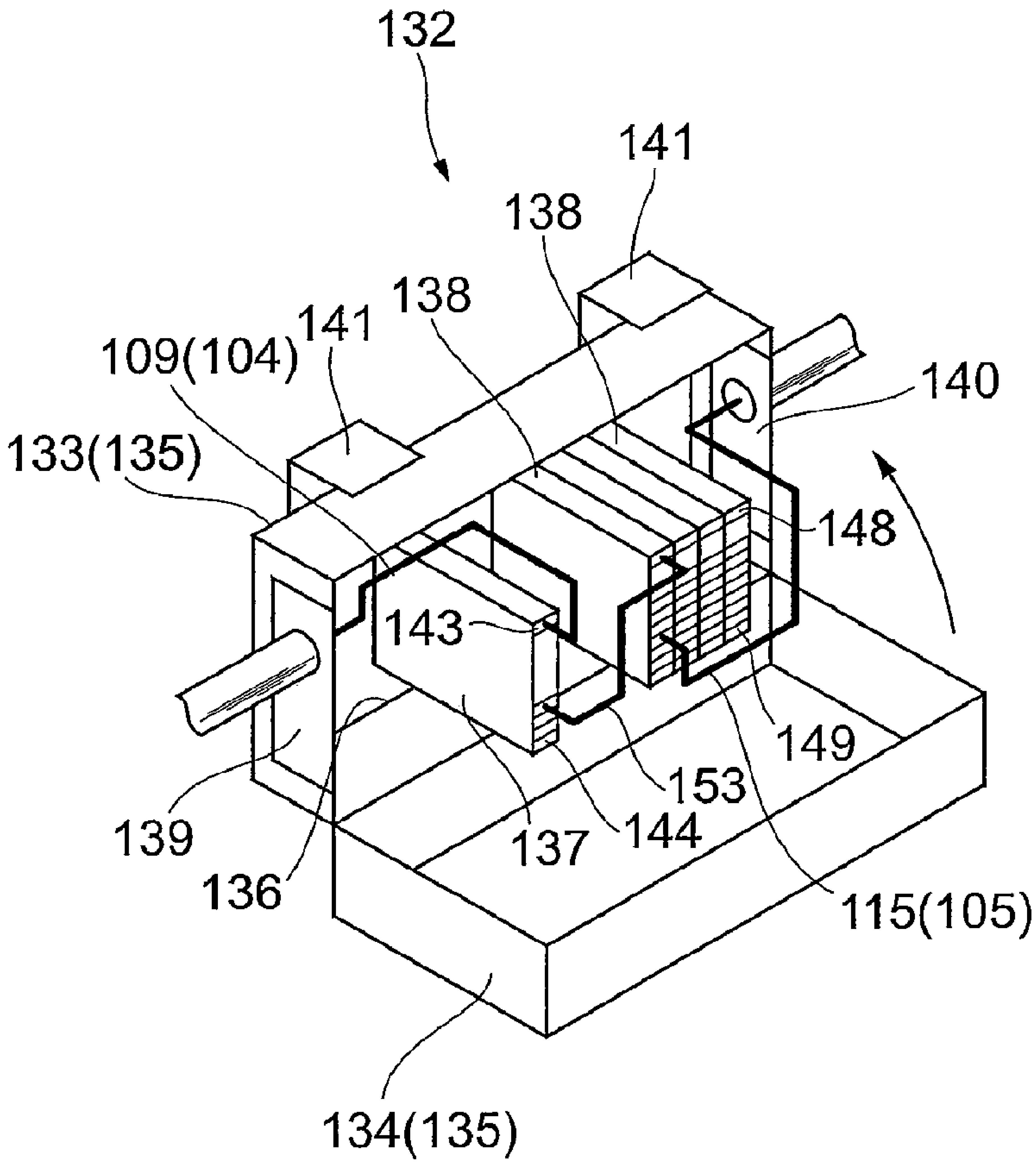
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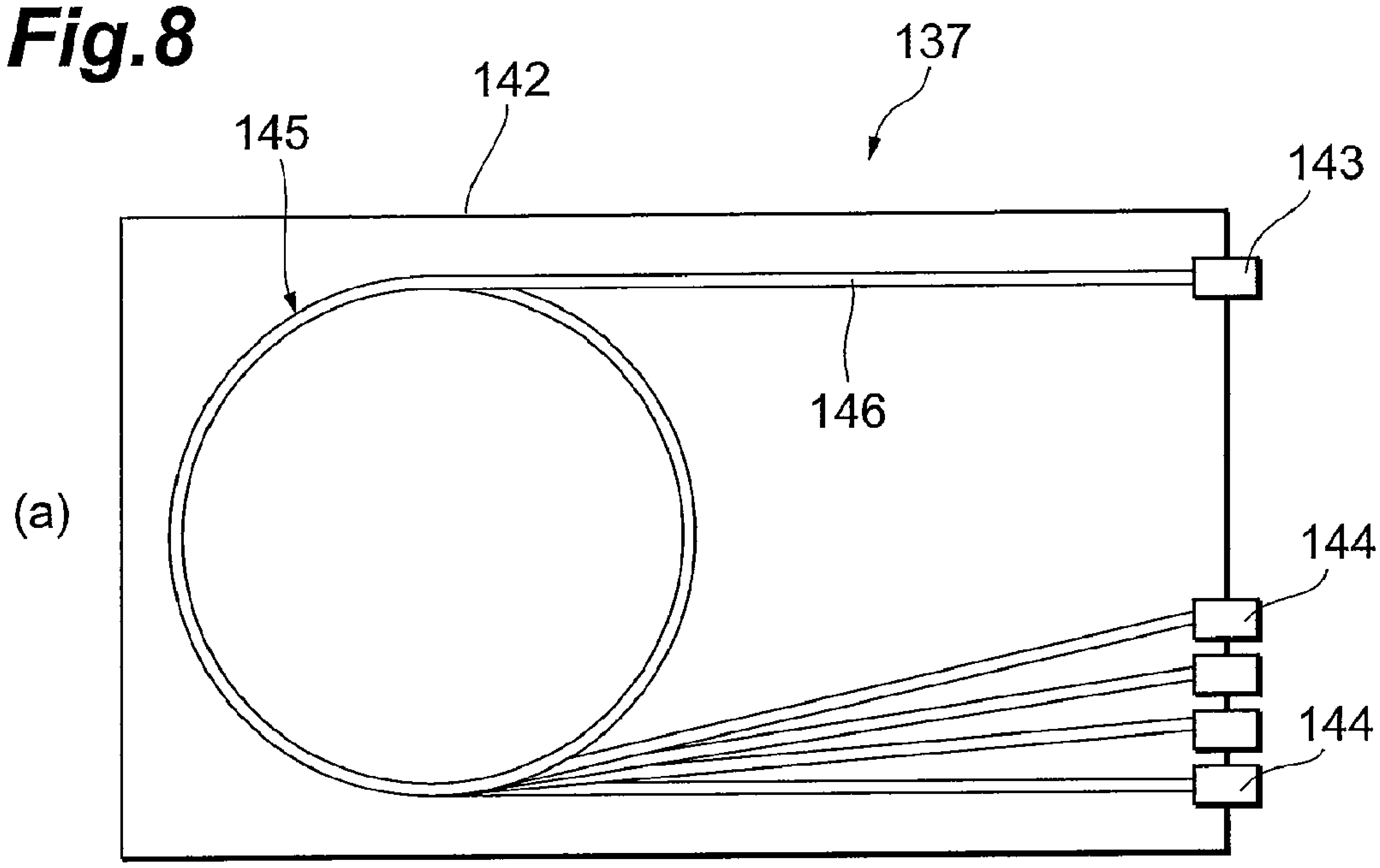
Fig.8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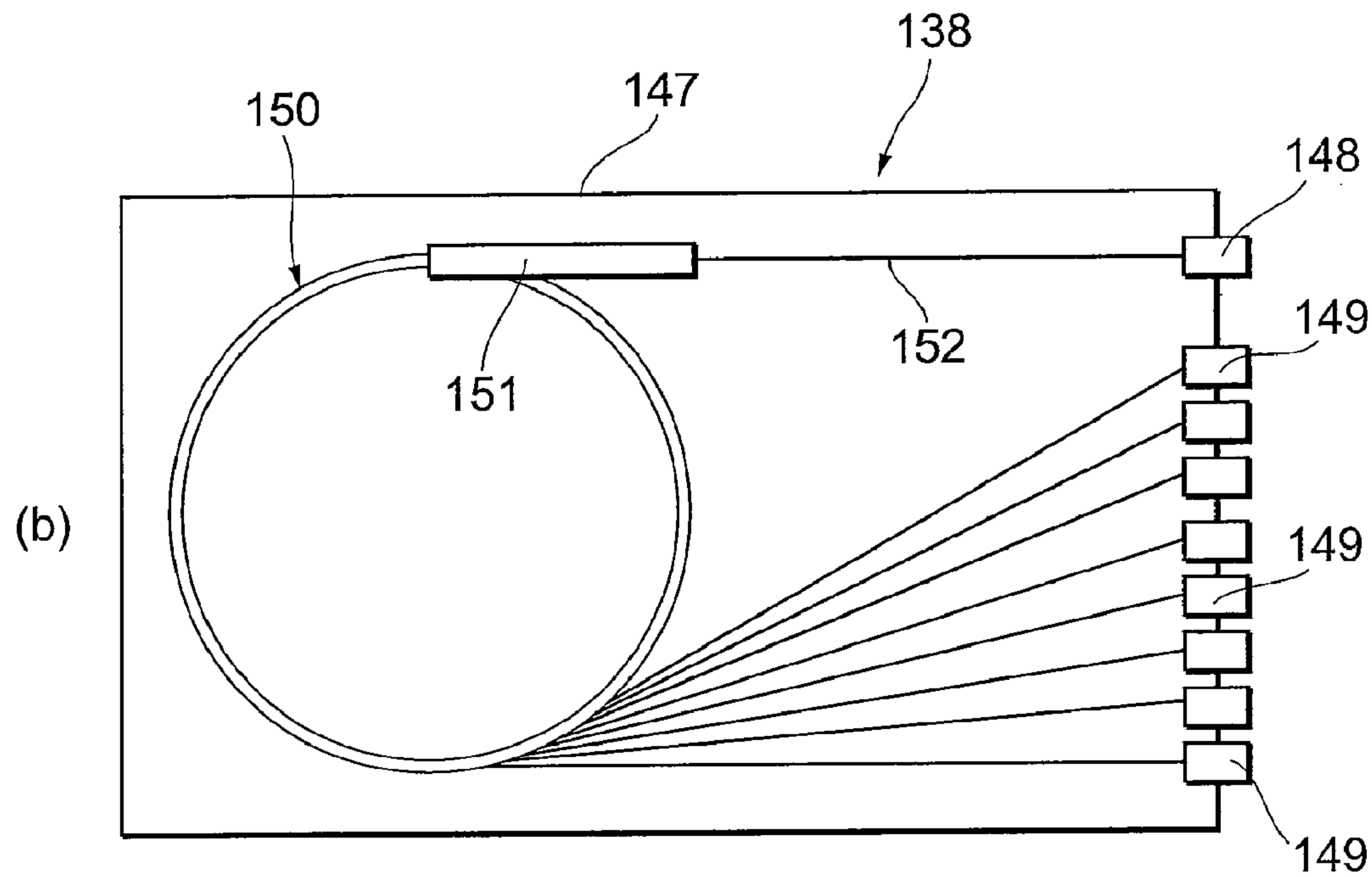
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Fig.9

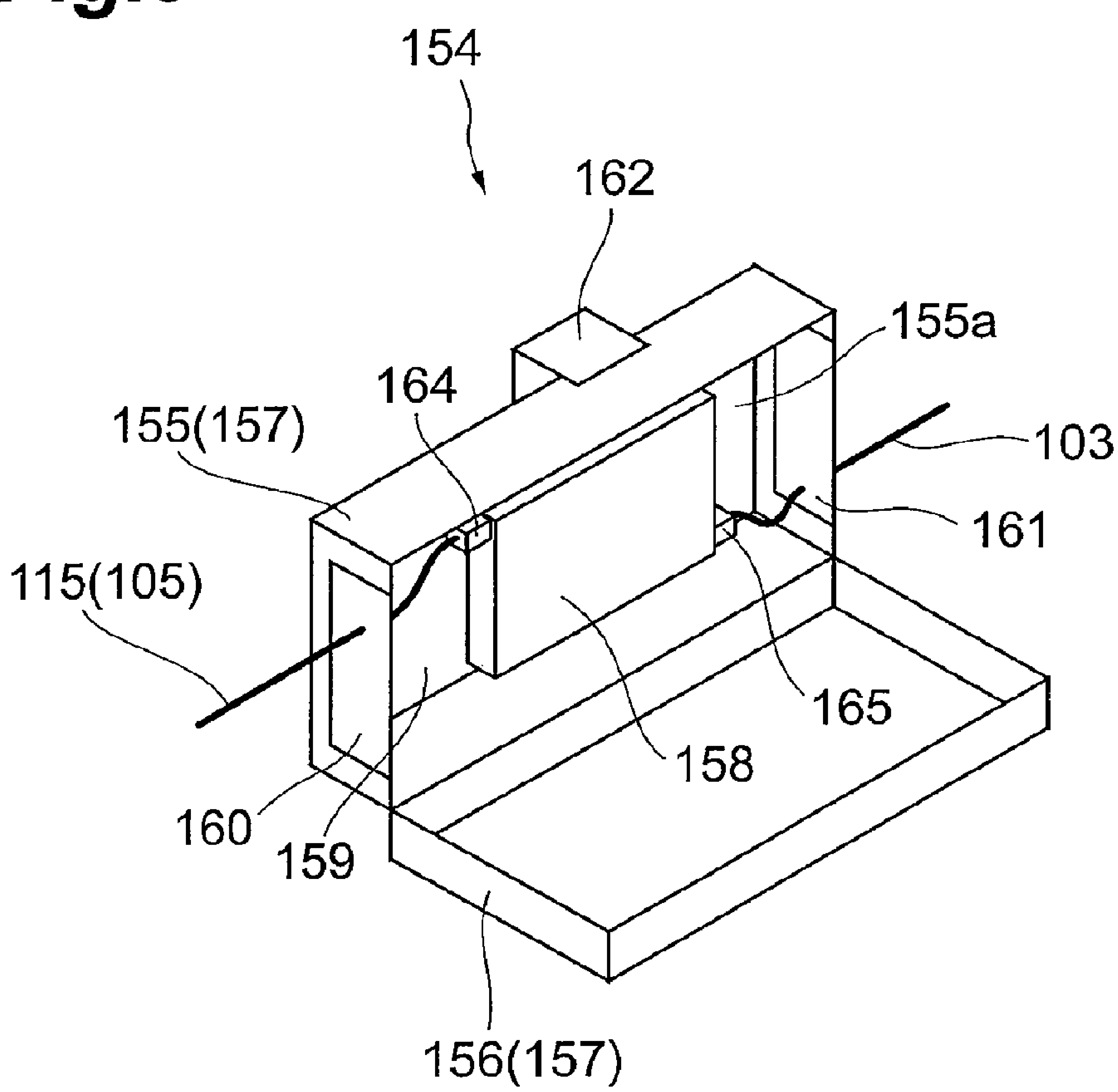
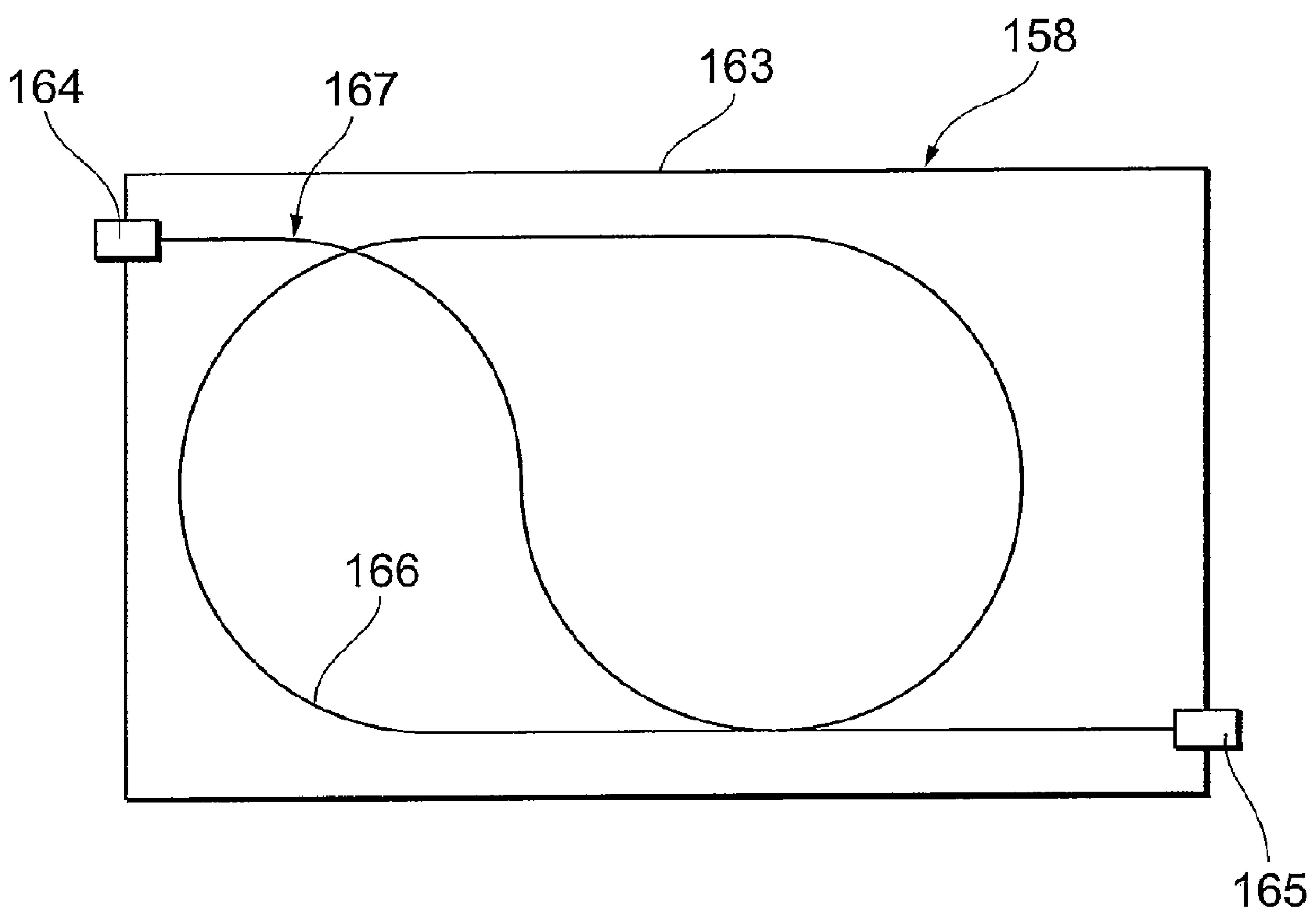


Fig.10



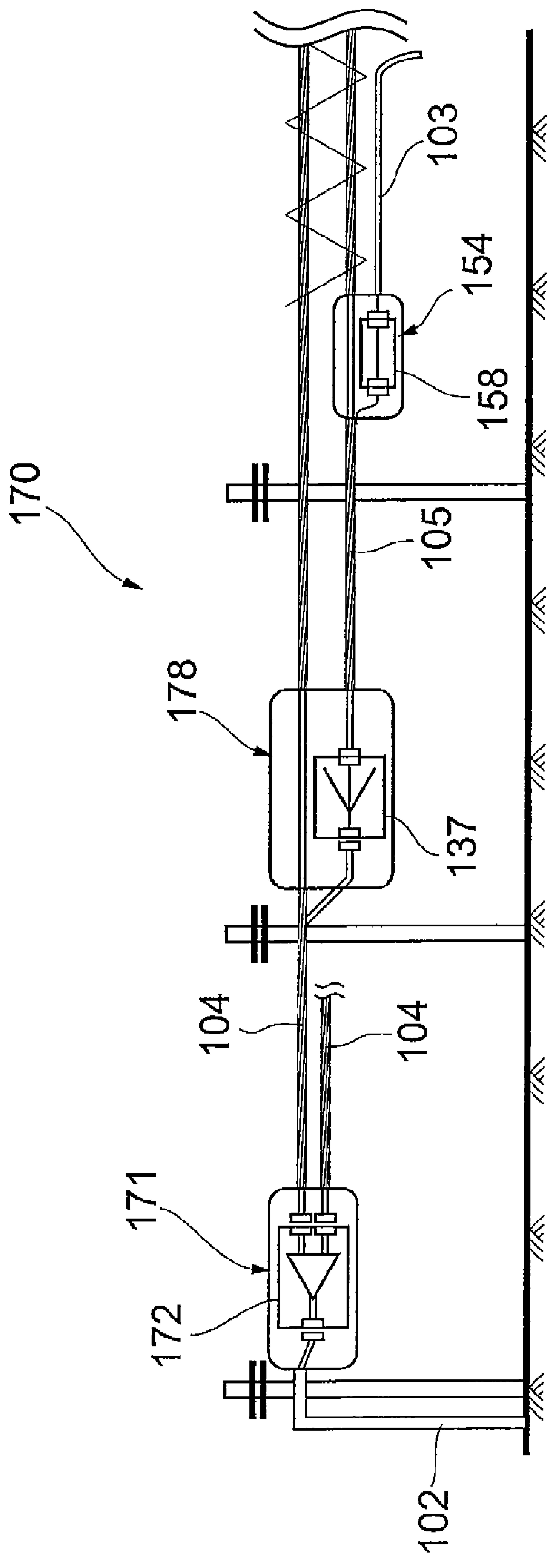


Fig.11

Fig.12

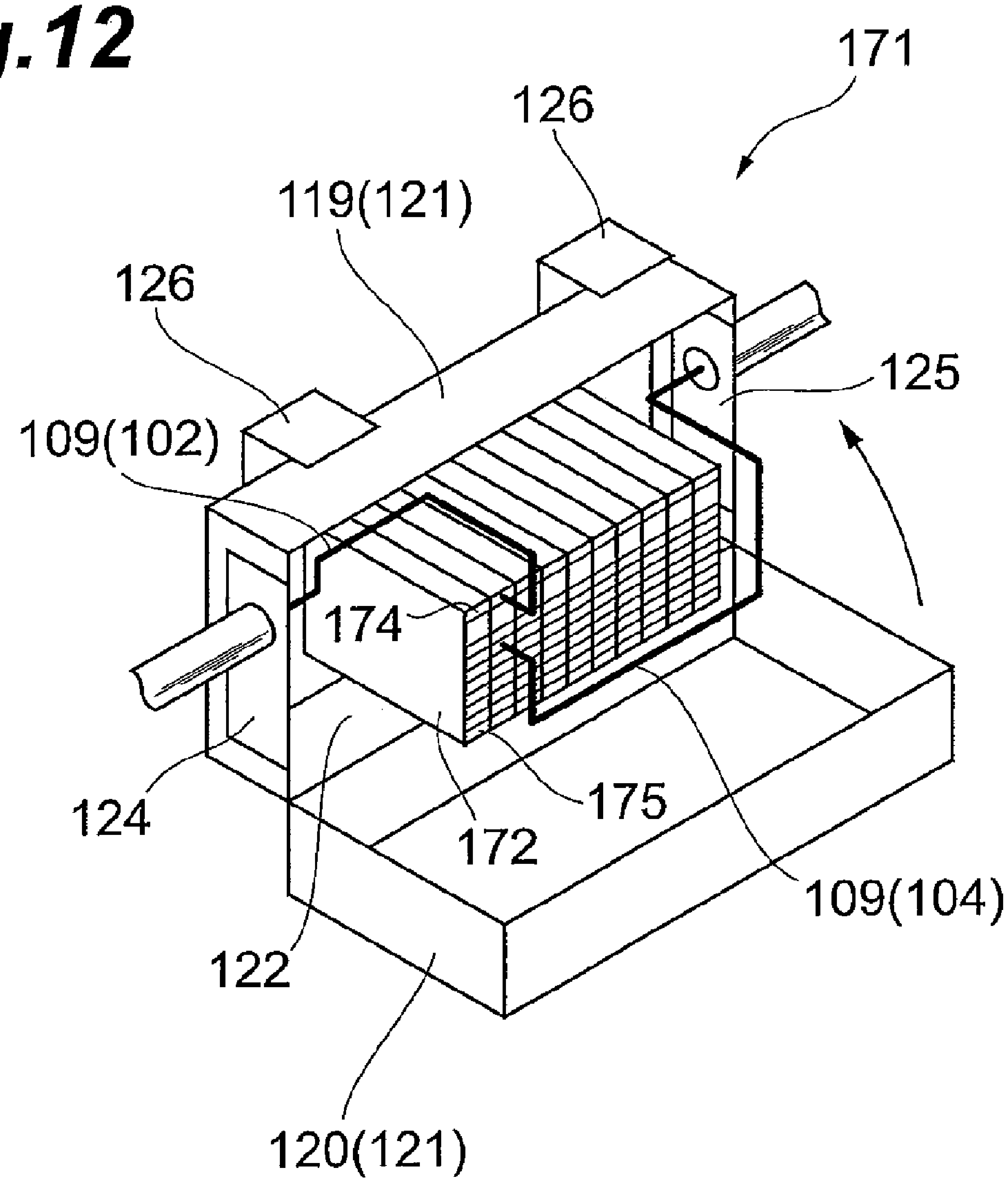

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Fig.13

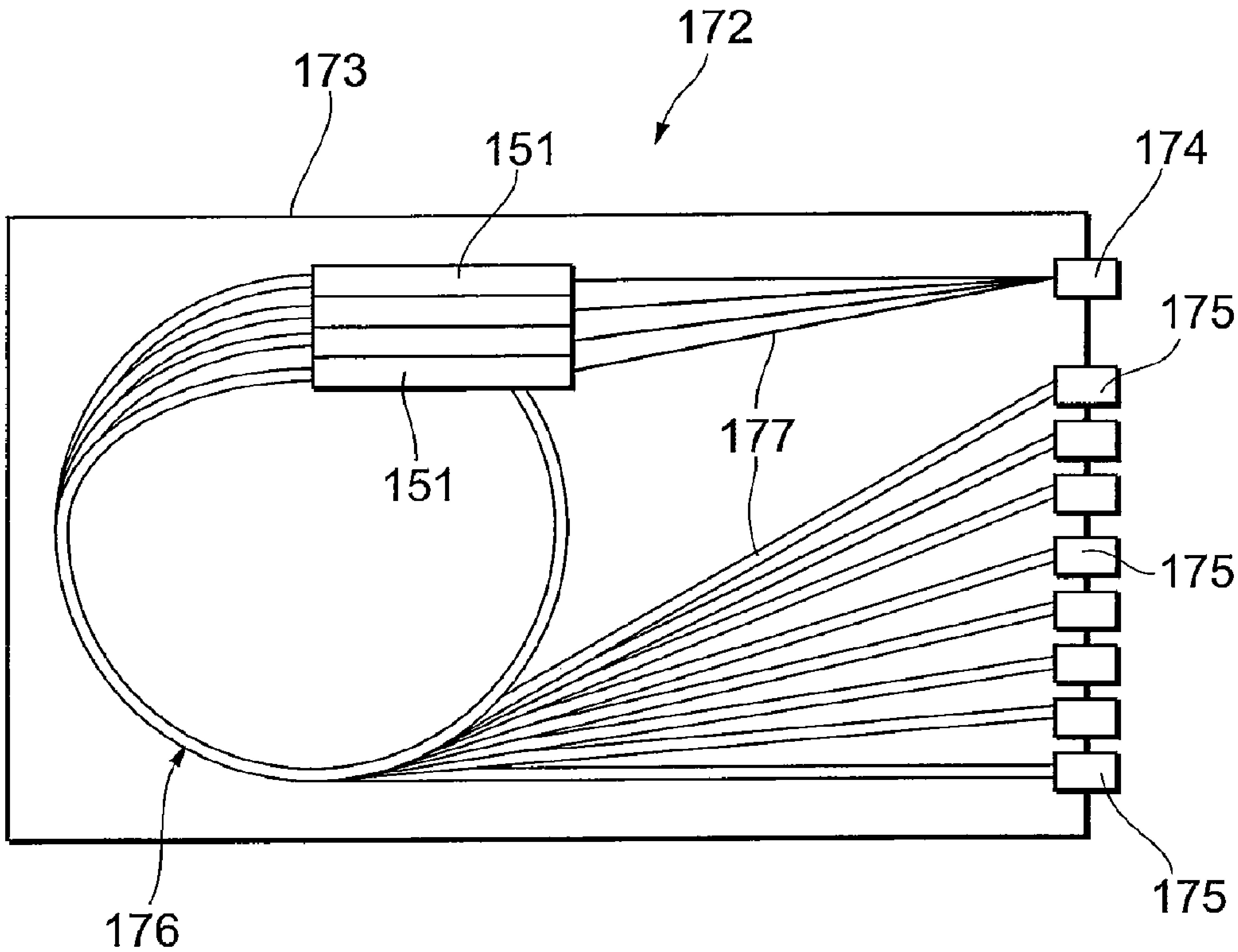
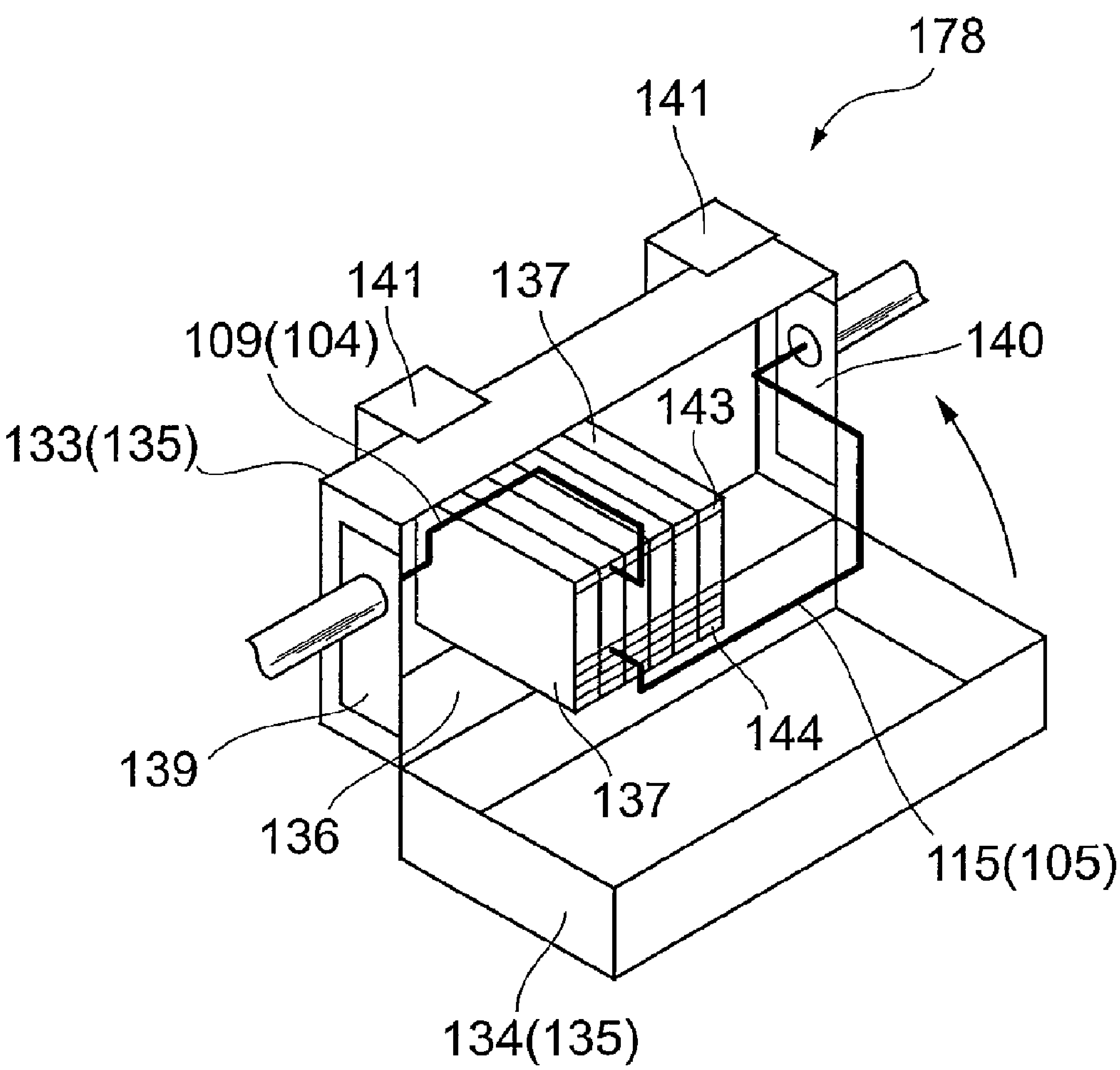


Fig.14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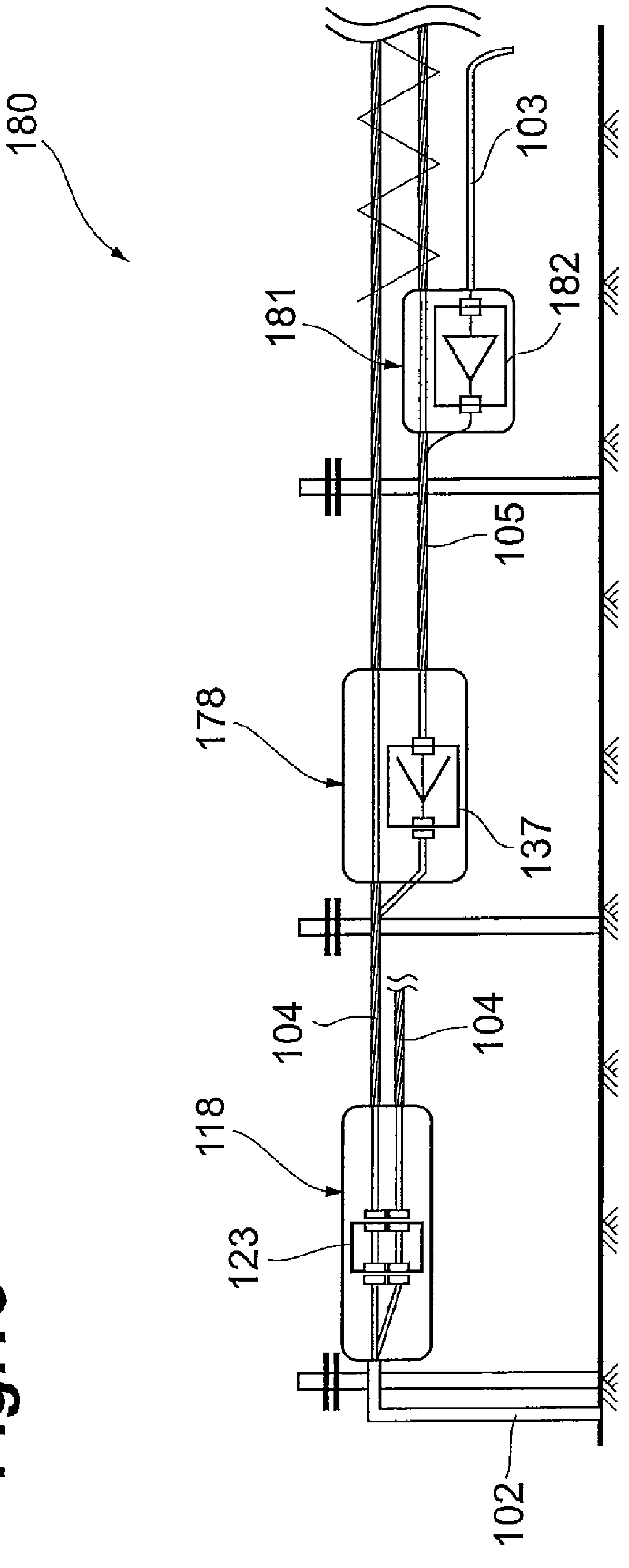

Fig.15

Fig.16

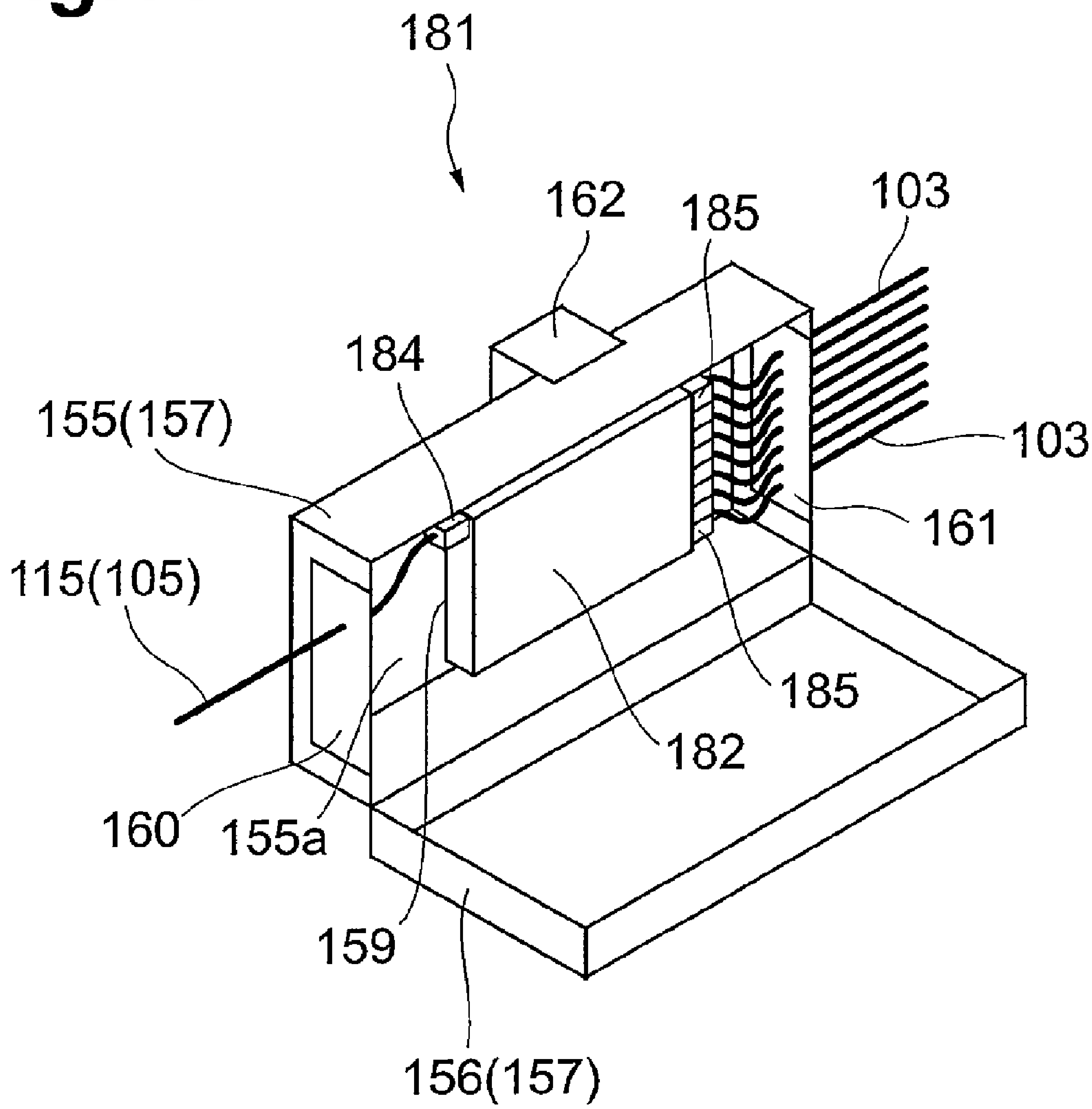
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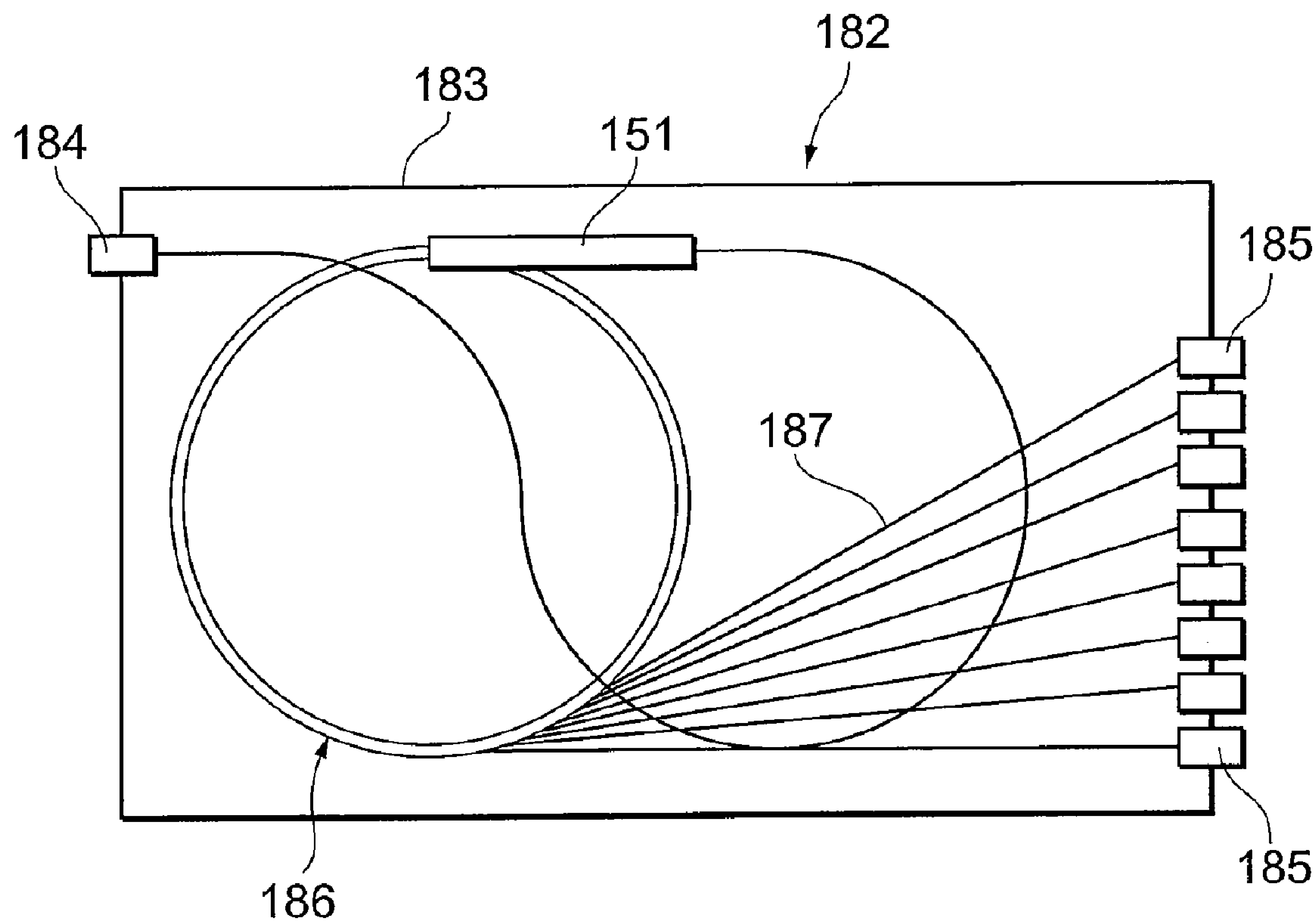
Fig.17



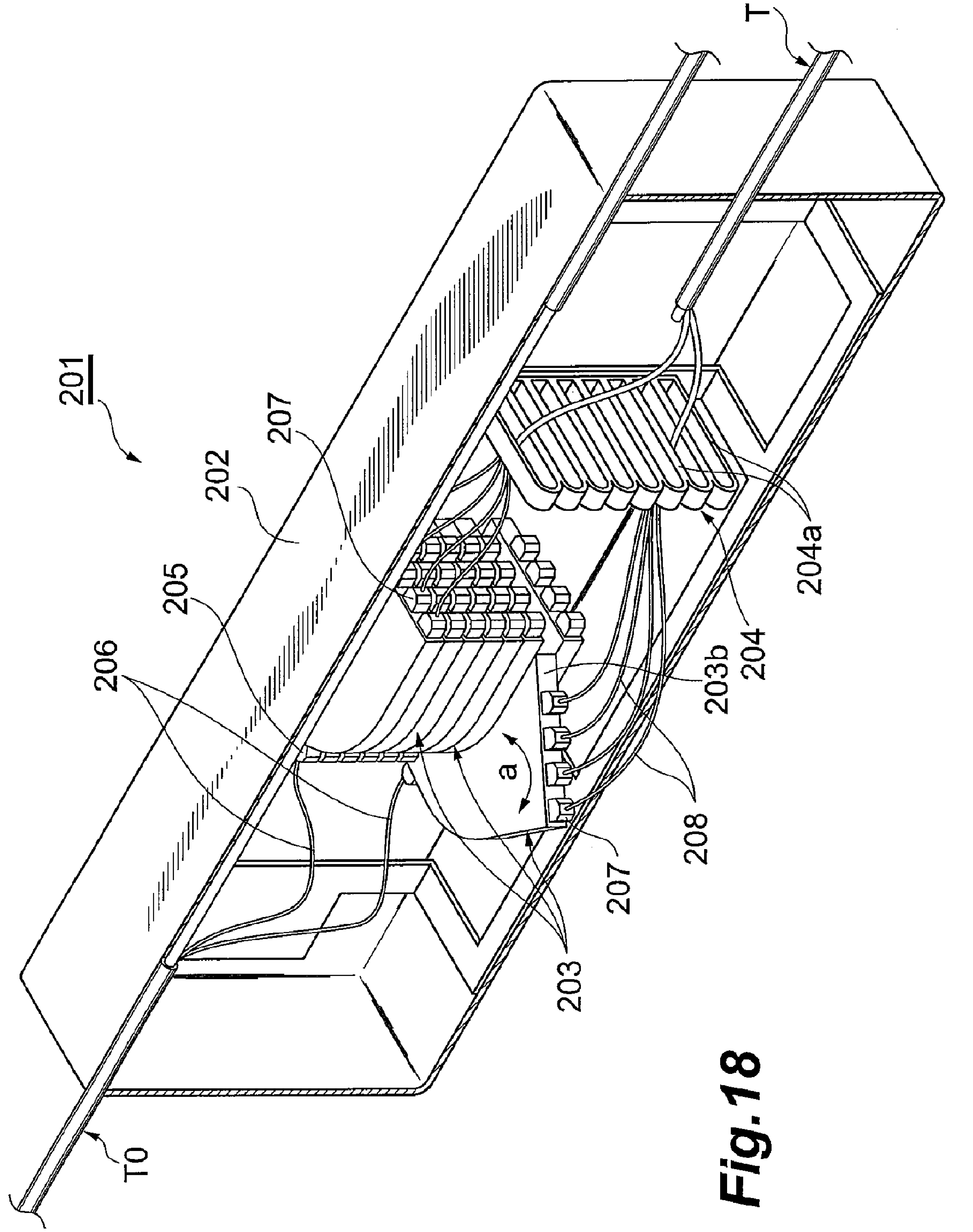
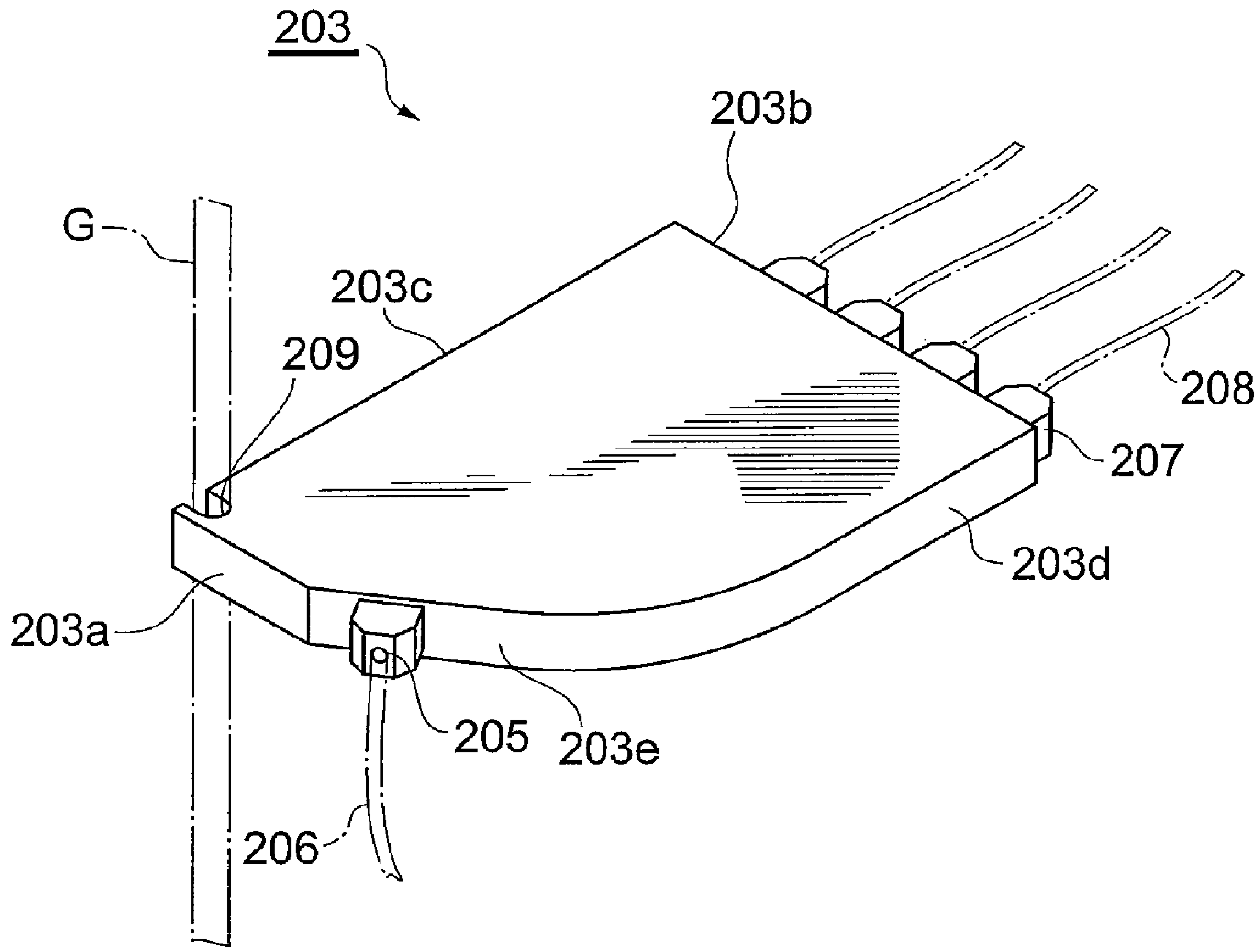


Fig.18

Fig.19



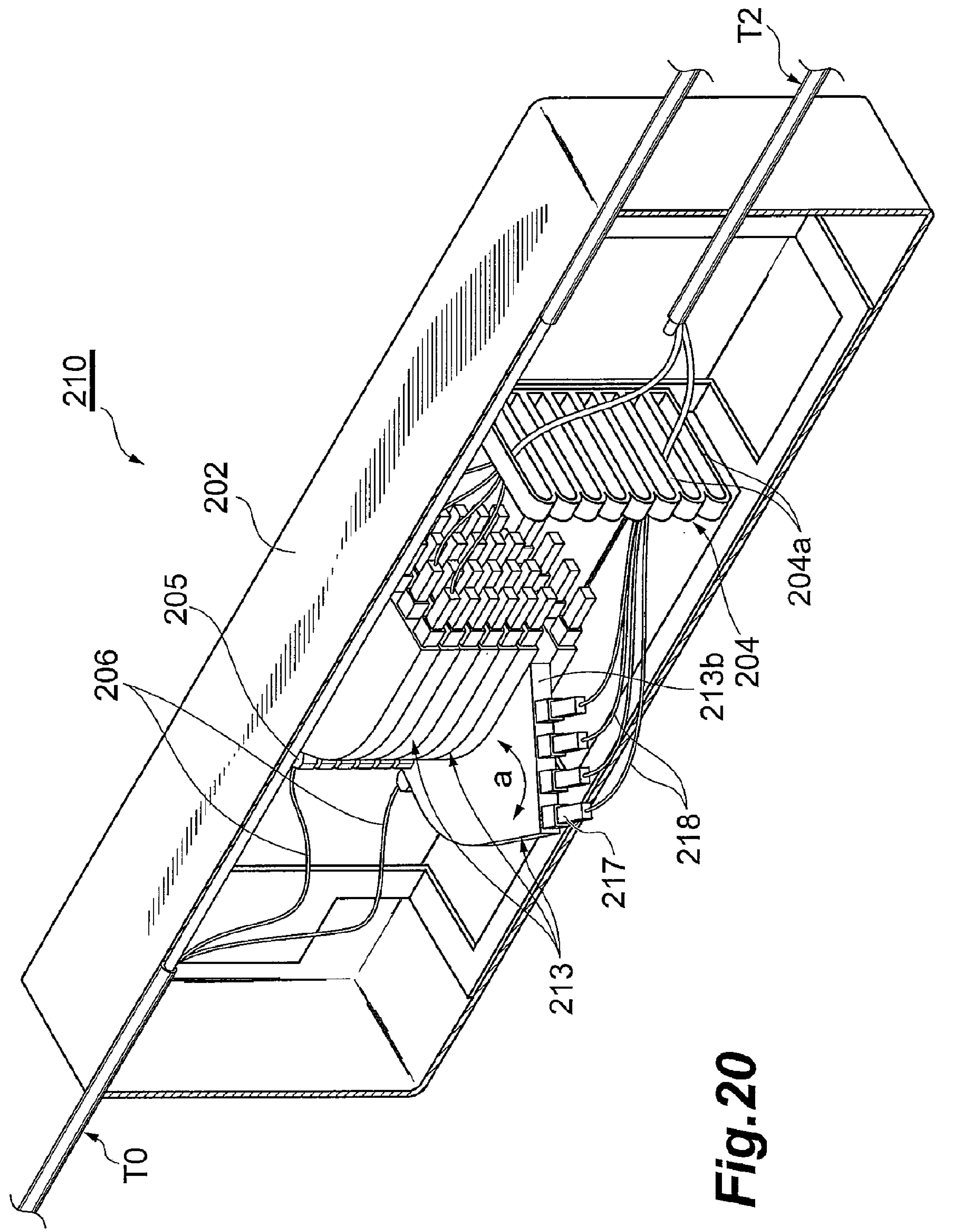


Fig.20

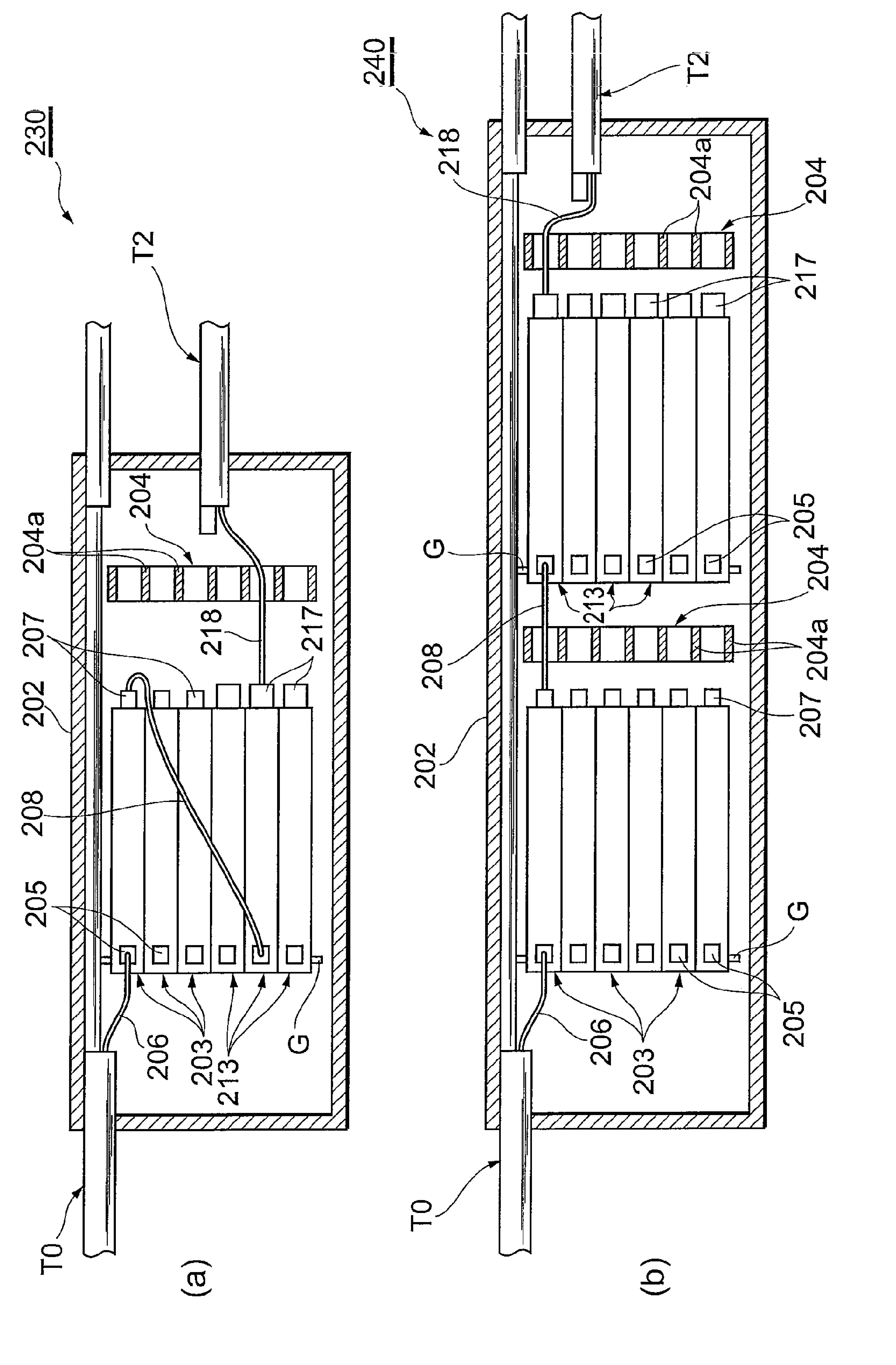

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Fig.21

Fig.22

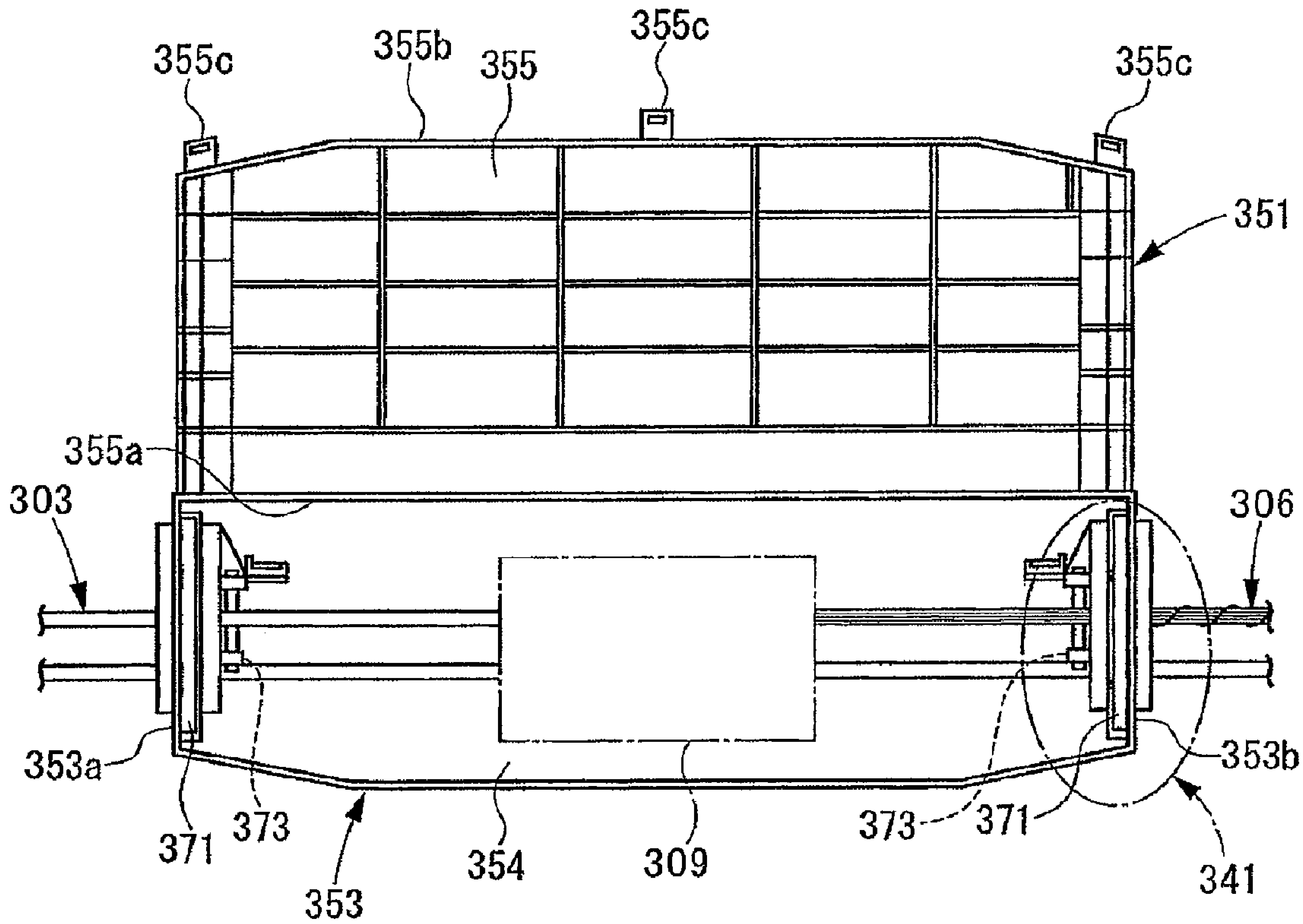
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Fig.23

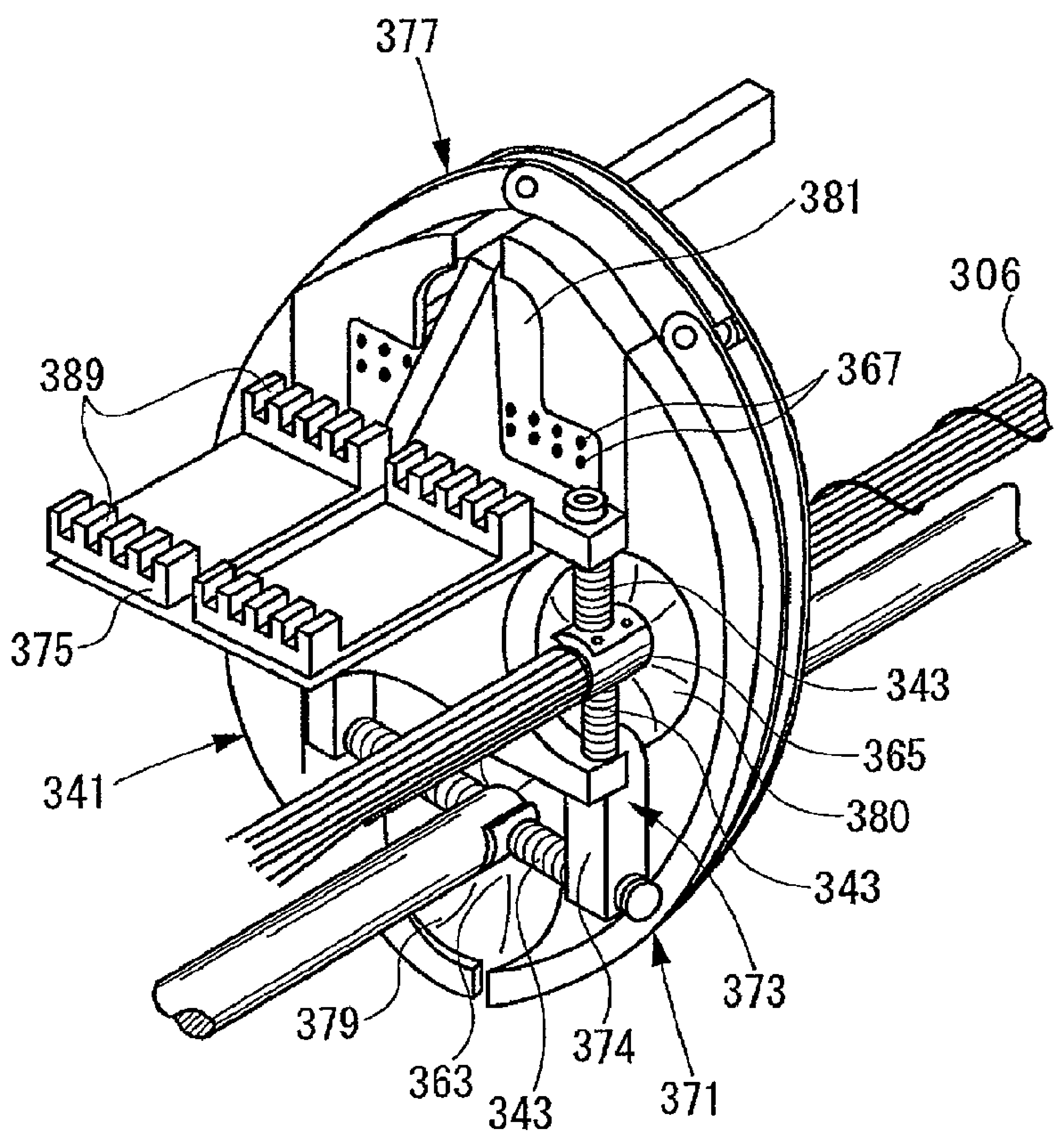
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Fig.24

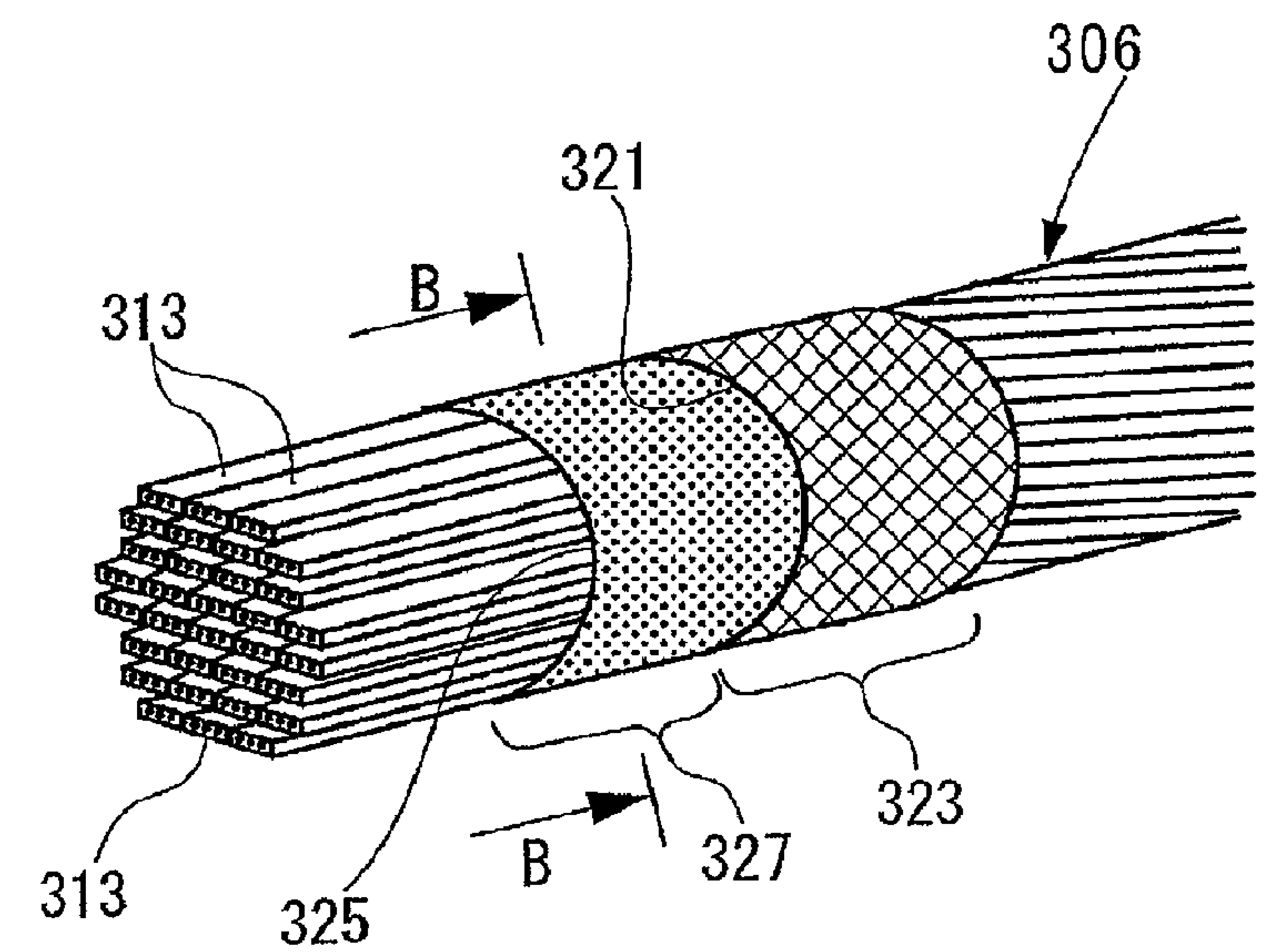

Fig.25

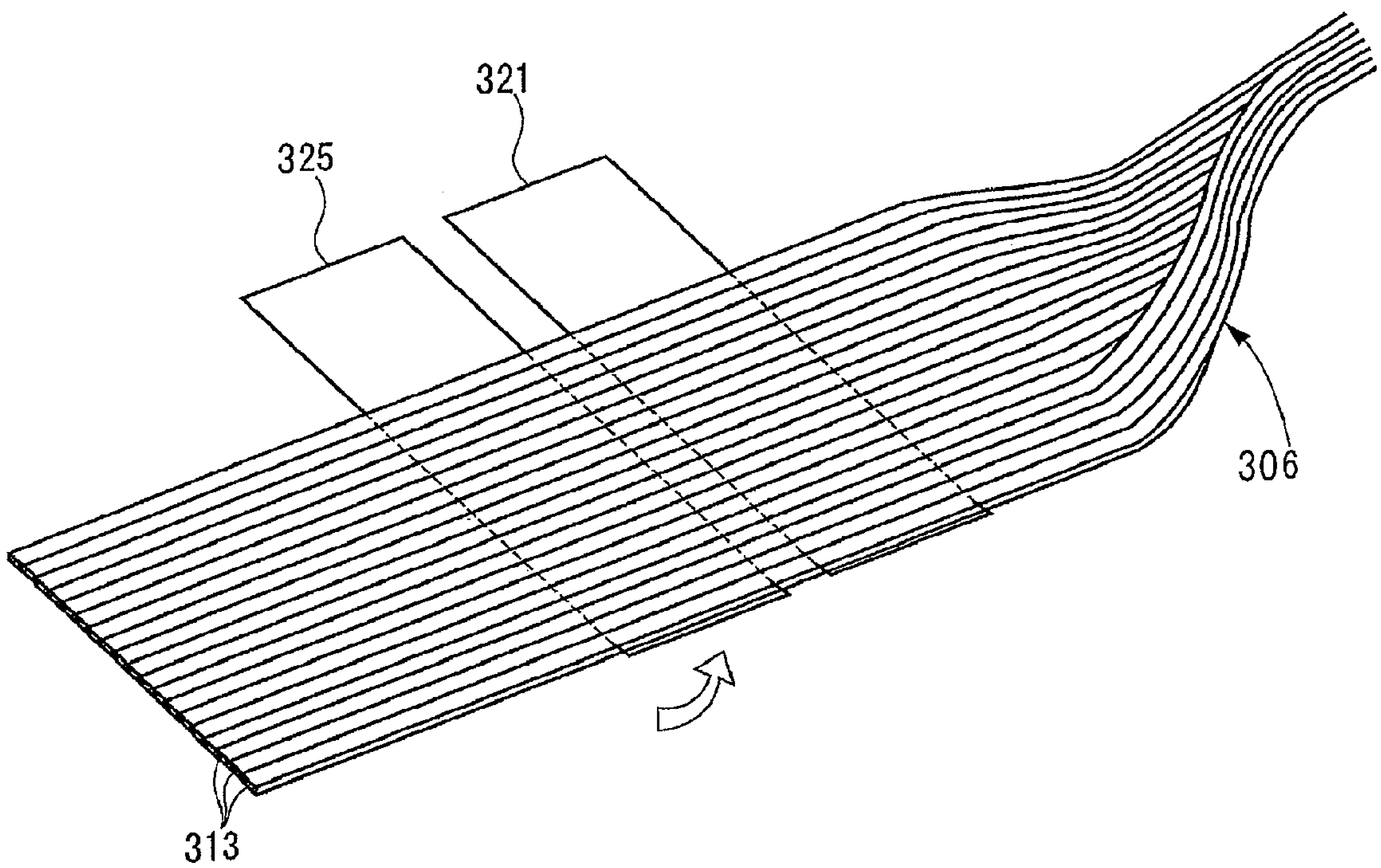

Fig.26

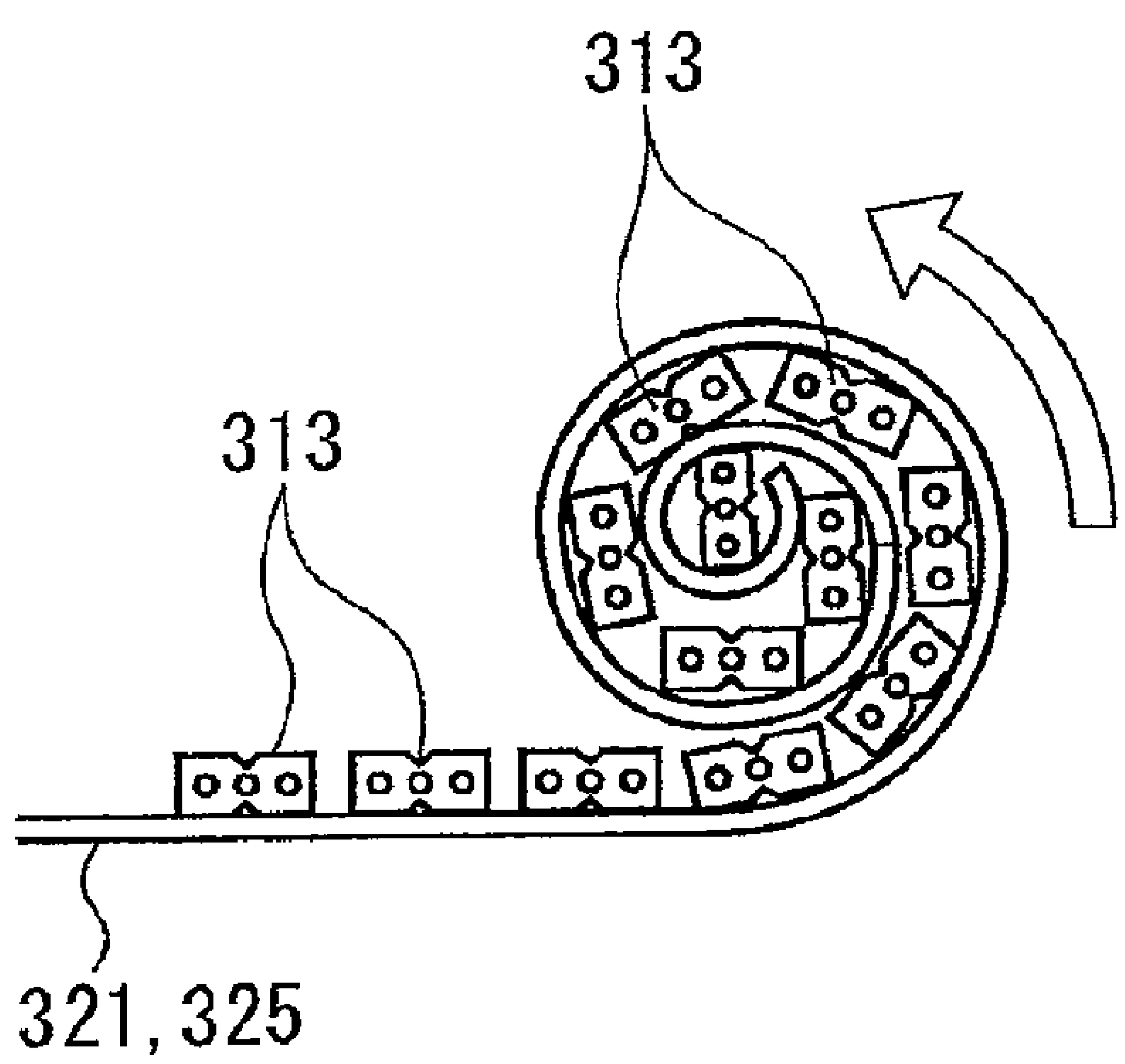

Fig.27

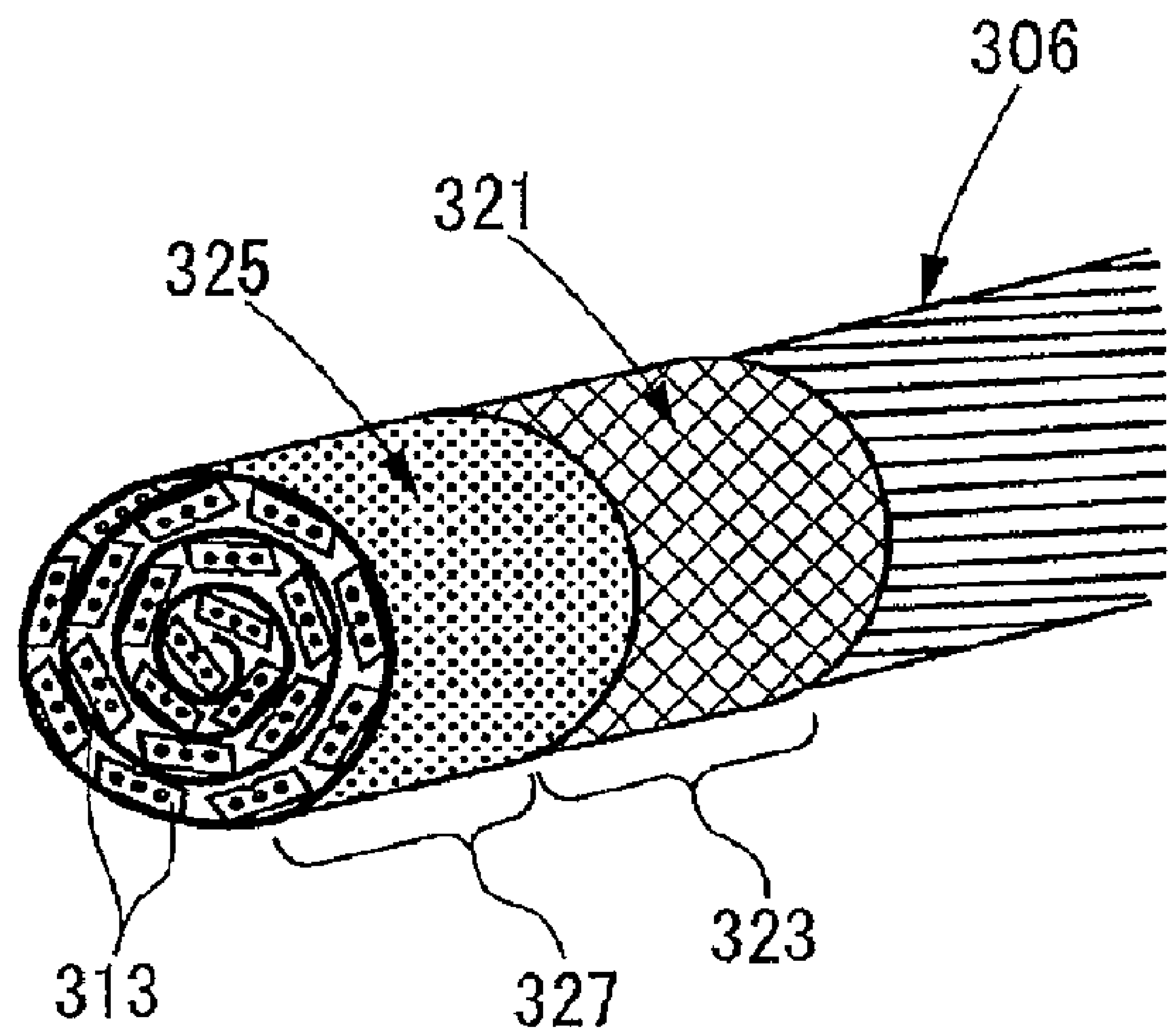

Fig.28

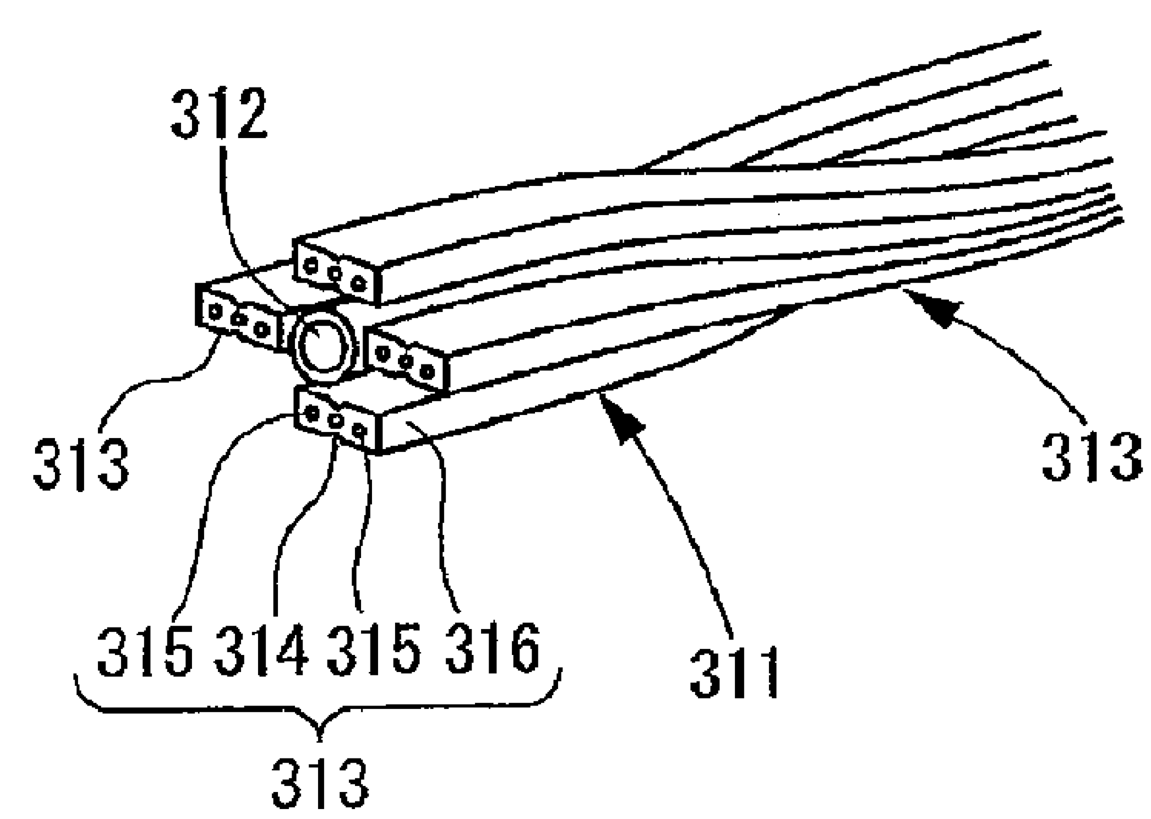

Fig.29

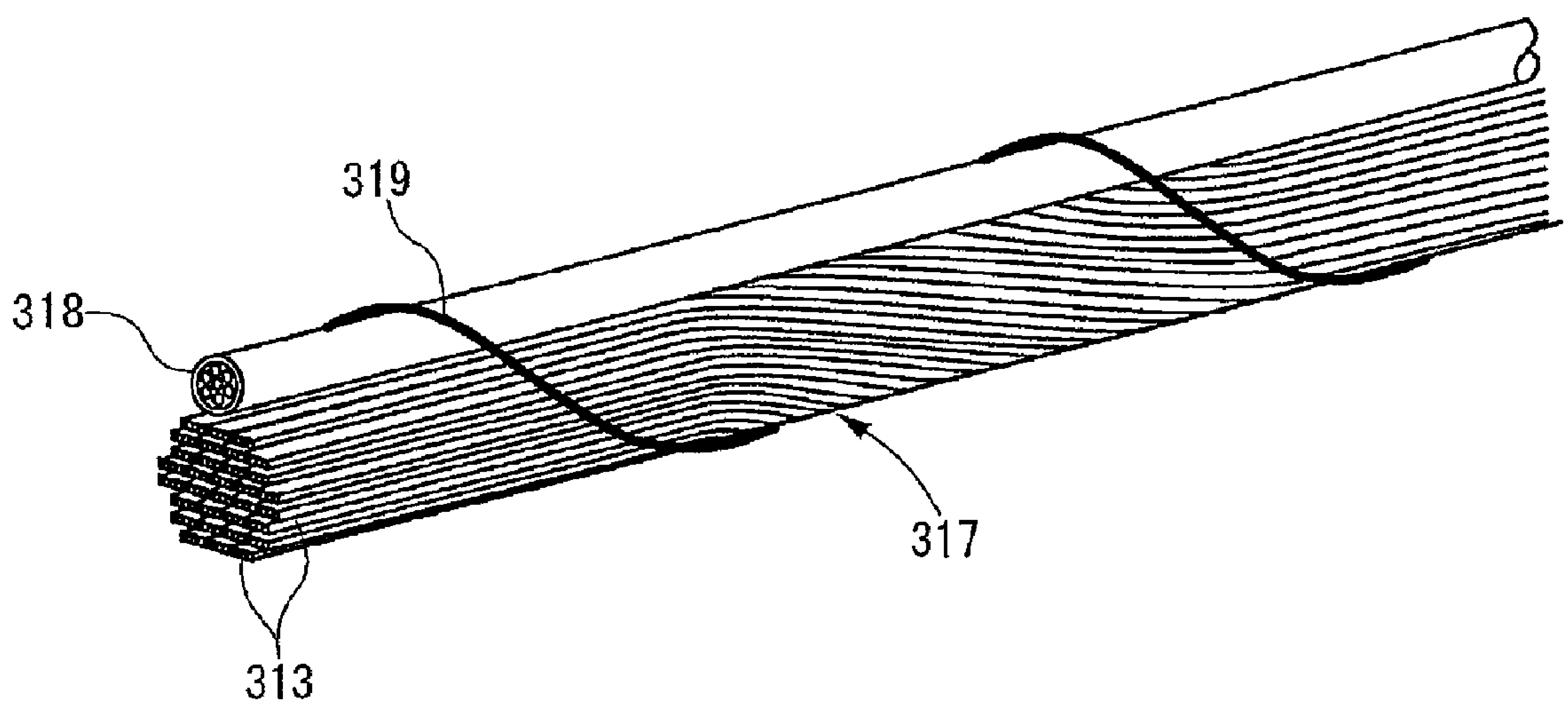

Fig.30

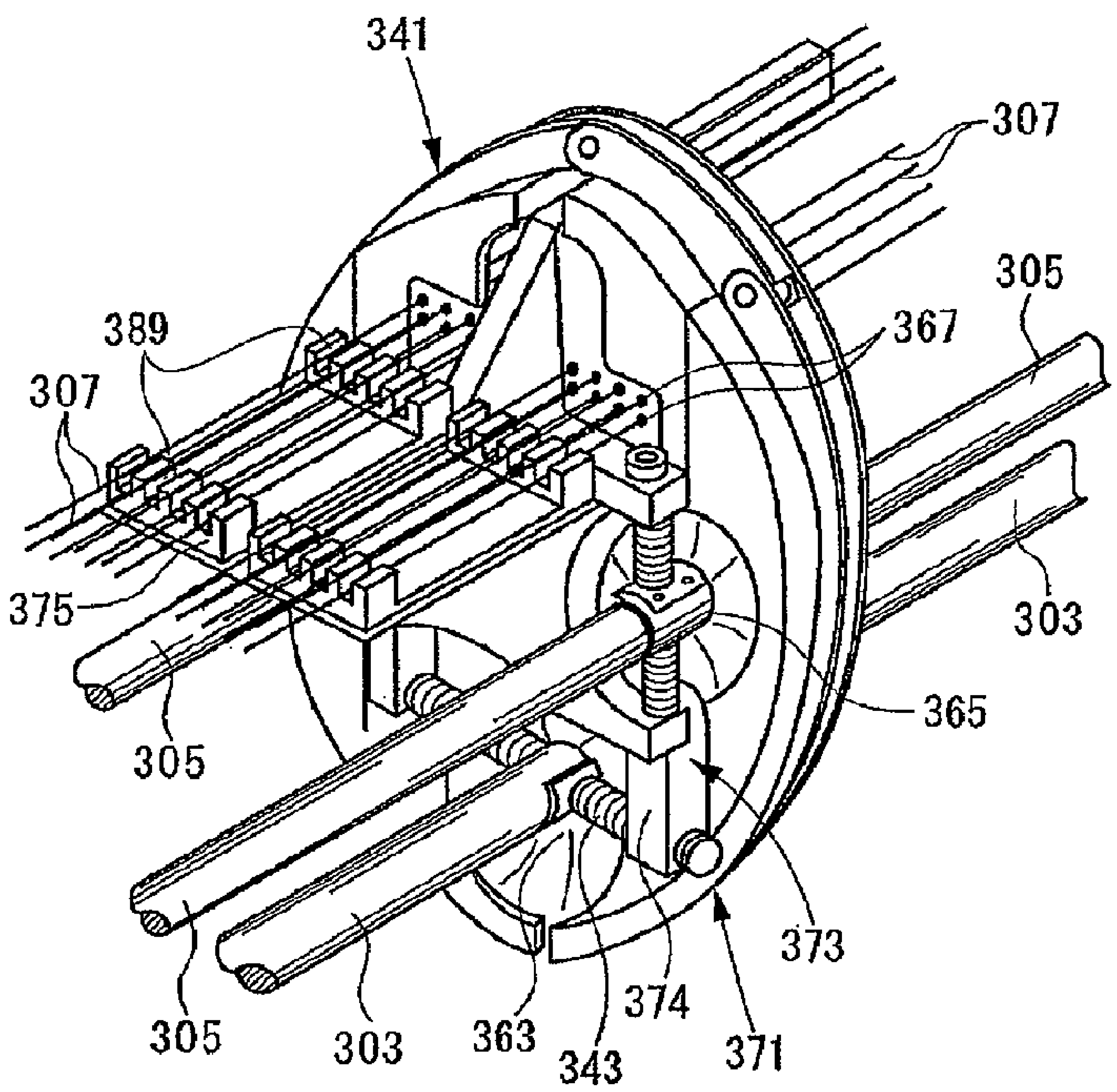
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Fig.31

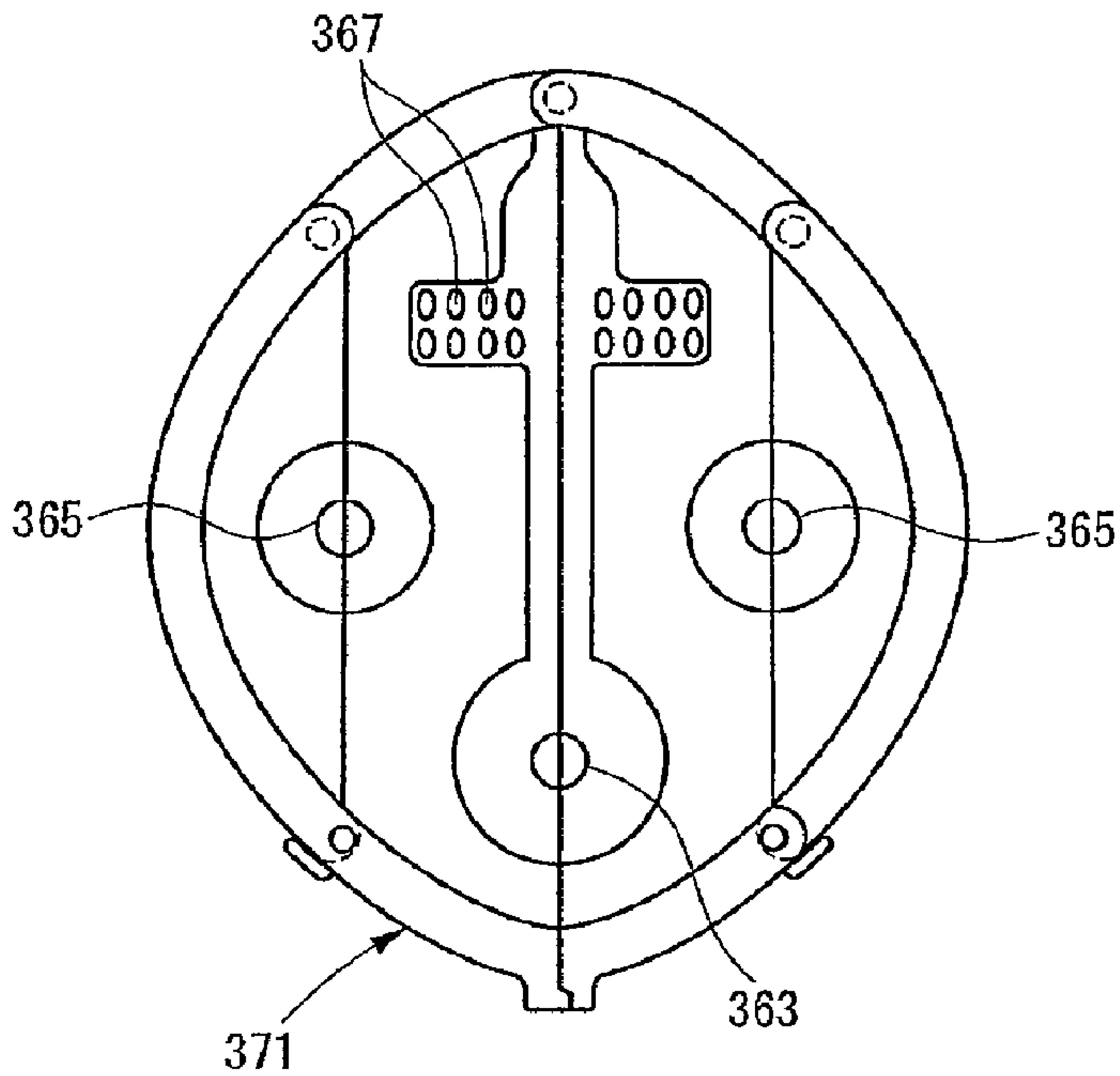
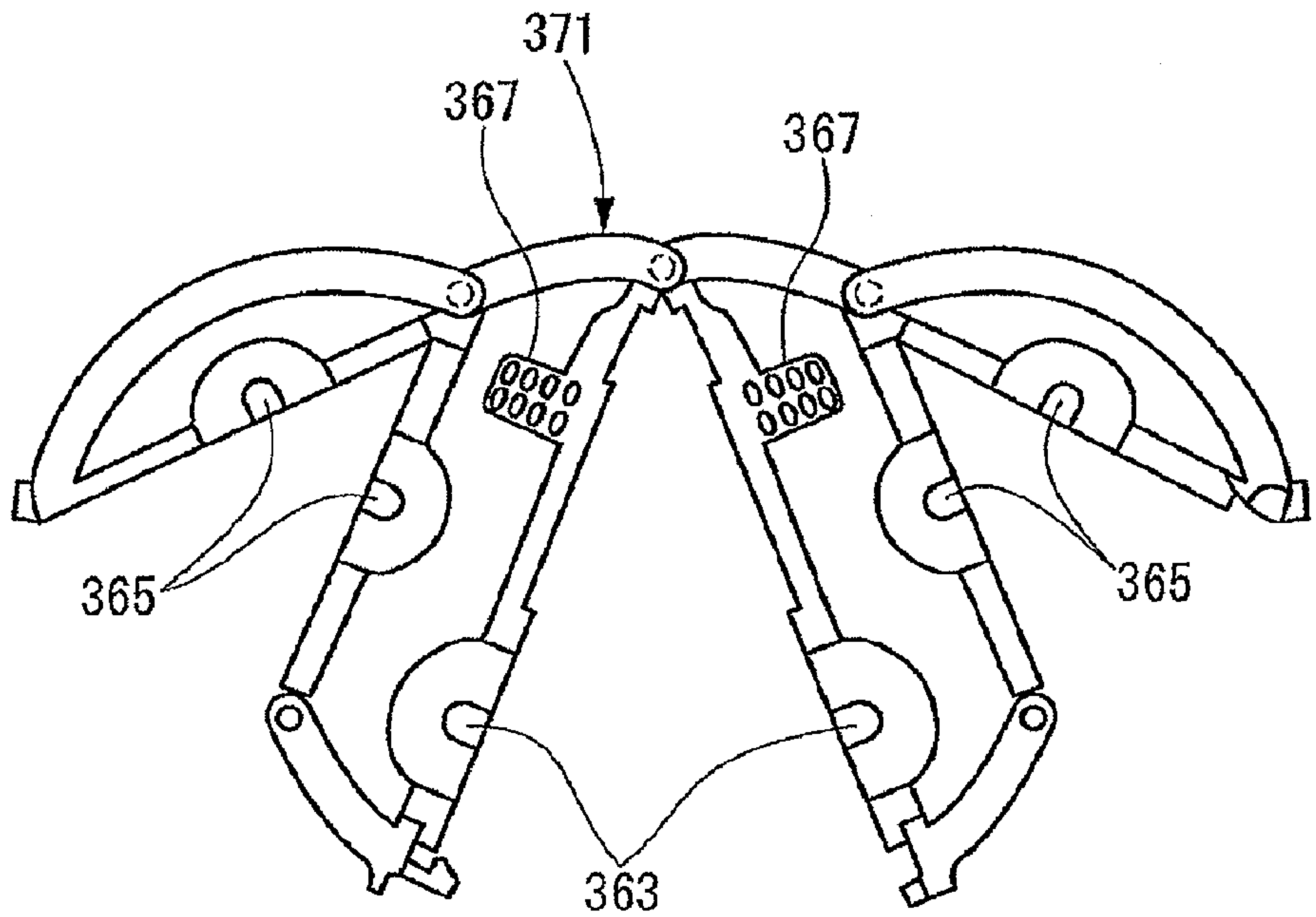


Fig.32



OPTICAL CABLE CONNECTING CLOSURE AND OPTICAL INTERCONNECTION SYSTEM

RELATED APPLICATIONS

This application is the U.S. National Phase under 35 U.S.C. §371 of International Application No. PCT/JP2008/054336, filed on Mar. 11, 2008, which in turn claims the benefit of Japanese Application Nos. 2007-062475, filed on Mar. 12, 2007, 2007-150223, filed on Jun. 6, 2007 and 2007-257953, filed on Oct. 1, 2007, the disclosures of which Applications are incorporated by reference herein.

TECHNICAL FIELD

The present invention relates to an optical cable connecting closure and an optical interconnection system.

BACKGROUND ART

As a conventional optical cable connecting closure, one described in Patent Literature 1 has been known, for example. The optical cable connecting closure described in Patent Literature 1 comprises a tray storing case provided within a closure main body and a tray for drop coated fibers which is constituted by stacked lower and upper trays and stored in the tray storing case so as to be freely insertable therein and removable therefrom. Each of the lower and upper trays is provided with a coated optical fiber leading-in/out section for leading coated optical fibers in and out, a connector storing section for storing a connector which connects the coated optical fibers to each other, a splitter storing section for storing an optical splitter connected to the coated optical fibers, and a coated fiber extra length storing section for storing an extra length of the coated optical fibers.

Known as an example of networks using optical fiber cables is a mode in which an optical cable is directly led into a dwelling (FTTH: Fiber To The Home). Known as an optical cable connecting closure for the FTTH is one comprising a splitter module section which optically splits a coated optical fiber or a branching coated fiber module section for multi-core/single-core conversion of the coated optical fiber (see, for example, Patent Literature 2). In such an optical cable connecting closure, a first coated optical fiber in a first optical cable and a second coated optical fiber in a second optical cable are connected to a module section through a termination board.

Patent Literature 1: Japanese Patent Application Laid-Open No. 2003-215355

Patent Literature 2: Japanese Patent Application Laid-Open No. 2007-121603

DISCLOSURE OF INVENTION

Technical Problem

For utilizing conventional optical cable connecting closures such as those mentioned above, demands for enhancing their convenience have been increasing. Therefore, in view of the foregoing, it is an object of the present invention to provide an optical cable connecting closure and optical interconnection system which can enhance the convenience.

Solution to Problem

One aspect of the present invention is achieved under the following circumstances. In the FTTH, optical cable connecting closures are placed at three cable connecting points (a feeder point, a distribution point, and a drop point) between a central office and a subscriber's home in a network using an optical cable, while the optical cable is branched in each closure, so that optical cables are interconnected like a tree from the central office acting as a start point.

Prevailing in such FTTH networks is a PON (Passive Optical Network) system in which an optical splitter is placed in the central office or closure, so as to divide a single-core optical signal into 32 at the maximum and transmit thus divided signals to subscribers' homes. While the optical cable on the central office side typically incorporates therein a ribbon-coated multicore optical fiber, it is connected to subscriber's lead-in optical cables on a core-to-core basis, which makes it necessary for one of the closures to carry out single-core separation.

In view of the foregoing, connecting functions required for the optical cable connecting closures totally vary among the cable connecting points. Currently, dedicated closures having different structures conforming to respective connecting functions required at the cable connecting points are placed there. However, this is very hard to respond to changes in connecting functions required for the closure if any and thus cannot cope with modifications in the optical interconnection system which are expected in future.

It is therefore an object of one aspect of the present invention to provide an optical cable connecting closure and optical interconnection system which can easily respond to changes in required connecting functions if any.

The optical cable connecting closure for achieving the above-mentioned object comprises a case having a module storing section and a connecting module, stored in the module storing section so as to be freely insertable therein and removable therefrom, for connecting first and second optical fibers to each other; wherein the connecting module has a module main body, first and second connectors attached to the module body and respectively connected to the first and second optical fibers, and an optical connecting section, provided in the module main body, for connecting the first and second connectors to each other; and wherein the module storing section is constructed such as to be able to store a plurality of kinds of connecting modules having the same module main body structure and different connecting functions in optical connecting sections.

In such an optical cable connecting closure, a plurality of kinds of connecting modules having the same module main body structure and different connecting functions in the optical connecting sections can be stored in the module storing section in the case so as to be freely insertable therein and removable therefrom. Therefore, when a connecting function required for an optical cable connecting closure is changed, it will be sufficient if a connecting module of a kind adapted to the required connecting function is stored in the module storing section of the case in place of the existing connecting module. Since the module main body of the connecting module is provided with the first and second connectors, connector-connecting the first and second optical cables makes it easier to exchange the connecting modules. This can easily respond to changes in connecting functions required for the optical cable connecting closure.

Preferably, the optical connecting section has any of functions of straightly connecting the first and second connectors to each other, connecting the first and second connectors to each other with a core number conversion, and connecting the first and second connectors to each other with optical branching.

Thus using three kinds of connecting modules having any of straight connecting, core number converting, and optical branching functions as a connecting function of the optical connecting section makes it possible to construct a plurality of modes of optical interconnection systems between an office-side optical cable and a subscriber-side optical cable, for example.

Preferably, the first and second connectors are provided at one end part of the module main body, while the module storing section has a structure for storing the connecting module vertically with respect to the case such that the first and second connectors face the front side of the case.

In such a structure, a plurality of connecting modules can be stored while being arranged in the module storing section of the case. Therefore, in an optical interconnection system constructed between an office-side optical cable and a subscriber-side optical cable, for example, it becomes suitable for an optical cable connecting closure connected to an office-side optical cable having a large number of cores of optical fibers.

The first connector may be provided at one end part of the module main body, the second connector may be provided at the other end part of the module main body, and the module storing section may have such a structure as to store the connecting module vertically with respect to the case such that the first and second connectors face left and right sides with respect to the front side of the case.

Such a configuration can make the case attain a smaller and thinner structure when only one connecting module is stored in the module storing section of the case. Therefore, in an optical interconnection system constructed between an office-side optical cable and a subscriber-side optical cable, for example, it becomes suitable for an optical cable connecting closure connected to a subscriber-side single-core optical cable.

The present invention provides an optical interconnection system for aerial optical interconnection between an office-side optical cable and a subscriber-side optical cable, the system comprising a first optical cable connected to the office-side optical cable, a second optical cable connected to the subscriber-side optical cable, an office-side closure connecting the office-side optical cable and the first optical cable to each other, a subscriber-side closure for connecting the subscriber-side optical cable and the second optical cable to each other, and an intermediate closure for connecting the first and second optical cables to each other; wherein the office-side closure, subscriber-side closure, and intermediate closure are each constituted by the above-mentioned optical cable connecting closure and have respective kinds of connecting modules different from each other.

In such an optical interconnection system, the above-mentioned optical cable connecting closure is used as each of the office-side closure, subscriber-side closure, and intermediate closure. Therefore, it can easily respond to changes in connecting functions required for the office-side closure, subscriber-side closure, and intermediate closure if any, for example, by replacing them with kinds of connecting modules conforming to the required connecting functions.

The foregoing one aspect of the present invention can easily respond to changes in connecting functions required for optical cable connecting closures if any, without newly designing and manufacturing an optical cable connecting closure. This can fully cope with modifications in optical interconnection systems which are expected in future.

Another aspect of the present invention is achieved under the following circumstances. As mentioned above, the extra length of coated fibers tends to become longer in the conventional optical cable connecting closures, since the first and second coated optical fibers are connected to the module section through a termination board. This may make it cumbersome to handle the coated optical fibers. As the extra length of coated fibers is longer, the coated optical fibers must be handled more carefully, thereby taking a longer time, thus lowering the working efficiency in connecting or storing the coated optical fibers.

It is therefore an object of another aspect of the present invention to provide an optical cable connecting closure which can shorten the extra length of coated fibers.

The optical cable connecting closure for achieving the above-mentioned object is an optical connecting closure used for connecting a first coated optical fiber in a first optical cable and a second coated optical fiber in a second optical cable to each other, the optical cable connecting closure comprising a splitter module section for optically splitting the first coated optical fiber and connecting thus split first coated optical fiber to the second coated optical fiber or a branching coated fiber module section for multicore/single-core-converting the first coated optical fiber and connecting thus converted first coated optical fiber to the second coated optical fiber, and a main body section for storing the module section; wherein the module section is provided with a first connector for connecting with the first coated optical fiber and a second connector for connecting with the second coated optical fiber.

In this optical cable connecting closure, the first coated optical fiber is directly connected to the first connector provided in the module section, while the second coated optical fiber is directly connected to the second connector provided in the module section. This can shorten the extra length of coated fibers, since the coated optical fibers are not connected to the module section through any termination board and thus can be inhibited from increasing their extra length. As a result, it becomes easier to handle the coated optical fibers, whereby the working efficiency in their connection or storage can be improved.

Preferably, the splitter module section and branching coated fiber module section have respective outer forms identical to each other. In this case, the splitter module section and branching coated fiber module section are compatible with each other, so that one used as the branching coated fiber module section can be switched to the splitter module section for use, for example. Therefore, the coated optical fibers can freely be laid within the main body section.

Preferably, the module section is arranged so as to be stacked. In this case, the module section is favorably stored within the main body section.

Preferably, the module section is arranged so as to be rotatable about a rotary axis provided near the first connector. In this case, rotating the module section as desired can locate the second connector at a position where the second coated optical fiber is easy to attach and remove. This can improve the detachability of the second coated optical fiber.

Preferably, the optical cable connecting closure further comprises a comb-toothed guide section, provided within the main body section, for guiding the second coated optical fiber. In this case, introducing the second coated optical fiber into a groove of the comb-toothed guide section can prevent the second coated optical fiber from causing congestion.

The present invention also provides an optical cable connecting closure used for connecting a first coated optical fiber in a first optical cable and a second coated optical fiber in a second optical cable to each other, the optical cable connecting closure comprising a splitter module section for optically splitting the coated optical fiber, a branching coated fiber module section for multicore/single-core-converting the coated optical fiber, and a main body section for storing the module sections; wherein one of the splitter module section and branching coated fiber module section is provided with a first connector for connecting with the first coated optical fiber; wherein the other of the splitter module section and branching coated fiber module section is provided with a second connector for connecting with the second coated optical fiber; and wherein each of the splitter module section and branching coated fiber module section is provided with a third connector for connecting with a third coated optical fiber for connecting the splitter module section and branching coated fiber module section to each other.

In this optical cable connecting closure, the first coated optical fiber is directly connected to the first connector provided in the splitter module section, while the second coated optical fiber is directly connected to the second connector provided in the branching coated fiber module section. The third coated optical fiber is directly connected to the third connector provided in each of the module sections. This can shorten the extra length of coated fibers, since the coated optical fibers are not connected to the module section through any termination board and thus can be inhibited from increasing their extra length. Since the main body section is shared by the splitter module section and branching coated fiber module section, it is not necessary to provide two kinds of main body sections respectively corresponding to them.

The foregoing aspect of the present invention can shorten the extra length of coated fibers. As a result, it becomes easier to handle the coated optical fibers, whereby the working efficiency in their connection or storage can be improved.

ADVANTAGEOUS EFFECTS OF INVENTION

The present invention can provide an optical cable connecting closure and optical interconnection system which can enhance the convenience by making it easier to respond to changes in required connecting functions if any or shortening the extra length of coated fibers.

Description of Embodiments

In the following, preferred embodiments of the present invention will be explained in detail with reference to the drawings. In the drawings, the same or equivalent constituents will be referred to with the same signs while omitting their overlapping descriptions. Terms such as “upper” and “lower” in the following explanation are based on the states illustrated in the drawings for convenience.

[First Embodiment]

FIG. **1** is a structural view of an optical interconnection system equipped with the first embodiment of the optical cable connecting closure in accordance with the present invention. In this drawing, the optical interconnection system is a system optically interconnecting a transmission apparatus within an office to a plurality of subscribers' homes with optical cables.

The optical interconnection system **101** comprises a feeder cable **102** led from under the ground into the air, a drop cable **103** extending from each subscriber's home, branch cables **104** connected to the feeder cable **102**, and a branch cable **105** connected to the drop cable **103** and branch cable **104**.

As illustrated in FIG. **2**, each of the feeder cable **102** and branch cable **104** has a spacer **107** provided with a tension member **106** at a center part thereof, while the spacer **107** is formed with a plurality of (**5** here) helical grooves (slots) **108**. A plurality of (**5** here) 4-core coated optical fiber ribbons (hereinafter simply referred to as 4-core coated fiber ribbons) **109** are arranged within each slot **108**. The spacer **107** is covered with a cable jacket **110** formed from polyethylene (PE) or the like.

As illustrated in FIG. **3**, the drop cable **103** has a support wire **111**, a single-core coated optical fiber **112**, and a pair of tension members **113** arranged on both sides of the coated optical fiber **112**. The support wire **111**, coated optical fiber **112**, and each of tension members **113** are collectively covered with a sheath **114** made of PE or the like.

As illustrated in FIG. **4**, the branch cable **105** comprises a plurality of (**8** here) single-core coated optical fibers **115** and a pair of tension members **116** arranged on both sides of the coated optical fibers **115**. The coated optical fibers **115** are arranged in two tiers. Each of the coated optical fibers **115** and tension members **116** are collectively covered with a sheath **117** made of PE or the like.

The feeder cable **102** and branch cables **104** are connected together through a feeder closure **118** at a feeder point. The feeder point is a point where an optical cable emerges from under the ground into the air.

As illustrated in FIG. **5**, the feeder closure **118** has a case **121** constituted by a box-shaped closure main body **119** and a door **120**. The door **120** is rotatably supported by a lower end part of the closure main body **119**, so as to be able to open and close the closure main body **119**. The closure main body **119** has a module storing section **122**. In the module storing section **122**, a plurality of connecting modules **123** are arranged along a width direction (lateral direction) while being erected (in a vertically placed state) with respect to the bottom face of the closure main body **119**.

Specifically, a storage rack of a front draw type (not depicted) is arranged in the module storing section **122**. Each of the connecting modules **123** are stored in the storage rack so as to be freely inserted therein and removed therefrom through the front side (door **120** side). When stored in the storage rack, the connecting modules **123** are secured to the storage rack through fixing means such as a screw or hot-plug board, for example.

One end part of the closure main body **119** is provided with a cable introducing section **124** having an inlet for introducing the 4-core coated fiber ribbons **109** taken out by removing the cable jacket **110** from an end part of the feeder cable **102**. The other end part of the closure main body **119** is provided with a cable introducing section **125** having an inlet for introducing the 4-core coated fiber ribbons **109** taken out by removing the cable jacket **110** from an end part of the branch cable **104**. Though the case **121** is formed from a plastic or the like, the cable introducing sections **124**, **125** are formed from a rubber or the like so as to secure sealability and waterproofness.

The back face of the closure main body **119** is provided with two attachments **126** for allowing an aerial messenger wire (not depicted) to hold and secure the feeder closure **118**. An L-shaped plate and a flat plate which hold the messenger wire are fastened together with the attachments **126** by screws, for example, whereby the feeder closure **118** is attached to the messenger wire.

As illustrated in FIGS. **5** and **6**, each connecting module **123** has a rectangular parallelepiped board-like module main body **127**, while a plurality of (**5** each here) 4-core MT connectors **128**, **129** are attached respectively in a vertical row to one end face of the module main body **127**.

An optical connecting section **130** for connecting the MT connectors **128**, **129** to each other are arranged within the module main body **127**. The optical connecting section **130** functions to straightly connect each pair of MT connectors **128**, **129** to each other through an optical fiber **131**.

Each connecting module **123** is stored in the module storing section **122** such that the MT connectors **128**, **129** face the front side of the case **120**. The 4-core coated fiber ribbons **109** of the feeder cable **102** are connector-connected to the MT connectors **128**, while the 4-core coated fiber ribbons **109** of the branch cable **104** are connector-connected to the MT connectors **129**. As a consequence, the 4-core coated fiber ribbons **109** of the feeder cable **102** and the 4-core coated fiber ribbons **109** of the branch cable **104** are connected together through the connecting module **123**.

The branch cables **104**, **105** are branch-connected to each other through a distribution closure **132** at a distribution point.

As illustrated in FIG. **7**, the distribution closure **132** has a case **135** constituted by a box-shaped closure main body **133** and a door **134**. The case **135** has the same structure as that of the case **120** of the above-mentioned feeder closure **118**. The closure main body **133** has a module storing section **136**, in which a connecting module **137** and a plurality of connecting modules **138** are arranged along the width direction while being erected with respect to the bottom face of the closure main body **133**. The structure for storing the connecting modules **137**, **138** in the module storing section **136** is totally the same as the structure for storing the connecting modules **123** in the above-mentioned module storing section **122**.

One end part of the closure main body **133** is provided with a cable introducing section **139** having an inlet for introducing the 4-core coated fiber ribbons **109** taken out by removing the cable jacket **110** from a middle part of the branch cable **104**. The other end part of the closure main body **133** is provided with a cable introducing section **140** having an inlet for introducing eight single-core coated optical fibers **115** taken out by removing the sheath **117** from an end part of the branch cable **105**. Though not illustrated in FIG. **7**, the branch cable **104** passes through the closure main body **133** via the cable introducing sections **139**, **140** (see FIG. **1**). The cable introducing sections **139**, **140** are formed from a rubber or the like as with the above-mentioned cable introducing sections **124**, **125**.

The back face of the closure main body **133** is provided with two attachments **141** for allowing a messenger wire (not depicted) to hold and secure the distribution closure **132**. The structure of the attachments **141** is the same as that of the above-mentioned attachments **126**.

As illustrated in FIGS. **7** and **8**(*a*), the connecting module **137** has a module main body **142**. The module main body **142** has the same structure and dimensions as those of the module main body **127** of the above-mentioned connecting module **123**. A 4-core MT connector **143** and a plurality of (**4** here) single-core connectors **144** are attached in a vertical row to one end face of the module main body **142**. An SC connector or FAS connector, for example, is used as the single-core connector **144**.

An optical connecting section **145** for connecting the MT connector **143** to each of the single-core connectors **144** is arranged within the module main body **142**. The optical connecting section **145** functions to connect the MT connector **143** to each of the single-core connectors **144** with 4-core/single-core conversion (core number conversion) through the optical fiber **146**.

As illustrated in FIGS. **7** and **8**(*b*), each connecting module **138** has a module main body **147** with the same structure and dimensions as those of the above-mentioned module main body **142**. A single-core connector **148** and a plurality of (**8** here) single-core connectors **149** are attached in a vertical row to one end face of each module main body **147**. As the single-core connectors **148**, **149**, those identical to the above-mentioned single-core connectors **144** are used.

An optical connecting section **150** for connecting the single-core connector **148** to each of the single-core connectors **149** is arranged within the module main body **147**. The optical connecting section **150** includes an optical splitter (optical branching device) **151** for splitting one optical input into a plurality of (**8** here) outputs and functions to connect the single-core connector **148** to each of the single-core connectors **149** with optical branching through the optical fiber **152**.

The connecting module **137** is stored in the module storing section **136** such that the MT connector **143** and single-core connectors **144** face the front side of the case **135**, while each connecting module **138** is stored in the module storing section **136** such that the single-core connectors **148**, **149** face the front side of the case **135**. The 4-core coated fiber ribbon **109** of the branch cable **104** is connector-connected to the MT connector **143**, while each of the coated optical fibers **115** of the branch cable **105** are connector-connected to the respective single-core connectors **149**. The single-core connectors **144**, **148** are connector-connected to each other through a connecting optical fiber **153**. As a consequence, the 4-core coated fiber ribbon **109** of the branch cable **104** and each coated optical fiber **115** of the branch cable **105** are connected to each other through the connecting module **137**, connecting optical fiber **153**, and connecting module **138**.

The branch cable **105** and drop cable **103** are branch-connected to each other through a drop closure **154** at a drop point.

As illustrated in FIG. **9**, the drop closure **154** has a case **157** constituted by a box-shaped closure main body **155** and a door **156**. The door **156** is rotatably supported by a lower end part of the closure main body **155**, so as to be able to open and close the closure main body **155**. The case **157** is smaller and thinner than the case **121** of the feeder closure **118**.

The closure main body **155** has a module storing section **159** for storing one connecting module **158** in a freely insertable and removable manner. With fastening means such as a screw or hook, for example, the connecting module **158** is attached to a rear inner face **155***a* of the closure main body **155** as being erected (in a vertically placed state) with respect to the bottom face of the closure main body **155**.

One end part of the closure main body **155** is provided with a cable introducing section **160** having an inlet for introducing each of the coated optical fibers **115** taken out by removing the sheath **117** from a middle part of the branch cable **105**. The other end part of the closure main body **155** is provided with a cable introducing section **161** having an inlet for introducing the drop cable **103**. Though not illustrated in FIG. **9**, the branch cable **105** passes through the closure main body **155** via the cable introducing sections **160**, **161** (see FIG. **1**). The cable introducing sections **160**, **161** are formed from a rubber or the like as with the above-mentioned cable introducing sections **124**, **125**.

The back face of the closure main body **155** is provided with attachment **162** for allowing a messenger wire (not depicted) to hold and secure the drop closure **154**. The structure of the attachments **162** is the same as that of the above-mentioned attachments **126**.

As illustrated in FIGS. **9** and **10**, the connecting module **158** has a module main body **163**. The module main body **163** has totally the same structure and dimensions as those of the module main body **127** of the above-mentioned connecting module **123**. A single-core connector **164** is attached to one end face of the module main body **163**, while a single-core connector **165** is attached to the other end face of the module main body **163**. As the single-core connectors **164**, **165**, those identical to the above-mentioned single-core connectors **144** are used.

An optical connecting section **167** functioning to straightly connect the single-core connectors **164**, **165** to each other through an optical fiber **166** is arranged within the module main body **163**.

The connecting module **158** is stored in the module storing section **159** such that the single-core connectors **164**, **165** face the left and right sides with respect to the front side of the case **157**. The coated optical fiber **115** of the branch cable **105** is connector-connected to the single-core connector **164**, while the single-core drop cable **103** is connector-connected to the single-core connector **165**. As a consequence, the coated optical fiber **115** of the branch cable **105** and the drop cable **103** are connected to each other through the connecting module **158**.

Since the cable connecting portions of the feeder closure **118**, distribution closure **132**, and drop closure **154** are modular and have connector-connectable structures in the foregoing optical interconnection system **101**, it becomes easy to carry out cable connecting operations, whereby the operation time can be shortened.

[Second Embodiment]

FIG. **11** is a structural view of another optical interconnection system equipped with the second embodiment of the optical cable connecting closure in accordance with the present invention. In this drawing, the members identical to those in the optical interconnection system illustrated in FIG. **1** will be referred to with the same signs while omitting their explanations.

In the optical interconnection system **170** illustrated in FIG. **11**, a feeder cable **102** and a branch cable **104** are connected to each other through a feeder closure **171** at a feeder point.

As illustrated in FIG. **12**, the feeder closure **171** has a case **121** similar to that of the above-mentioned feeder closure **118**, while a plurality of connecting modules **172** are arranged along the width direction as being erected with respect to the bottom face of a closure main body **119**.

As illustrated in FIGS. **12** and **13**, each connecting module **172** has a module main body **173** having the same structure and dimensions as those of the above-mentioned connecting module **123**. A 4-core MT connector **174** and a plurality of (**8** here) 4-core MT connectors **175** are attached in a vertical row to one end face of the module main body **173**.

An optical connecting section **176** for connecting the MT connectors **174**, **175** together is arranged within the module main body **173**. The optical connecting section **176** includes four optical splitters **151** (mentioned above) and functions to connect the MT connectors **174**, **175** together with optical branching and consolidating through optical fibers **177**.

Each connecting module **172** is stored in the module storing section **122** such that the MT connectors **174**, **175** face the front side of the case **120**. The 4-core coated fiber ribbon **109** of the feeder cable **102** is connector-connected to the MT connector **174**, while the 4-core coated fiber ribbons **109** of the branch cable **104** are connector-connected to the respective MT connectors **175**. As a consequence, the 4-core coated fiber ribbon **109** of the feeder cable **102** and the 4-core coated fiber ribbons **109** of the branch cable **104** are connected to each other through the connecting module **172**.

The branch cables **104**, **105** are branch-connected to each other through a distribution closure **178** at a distribution point.

As illustrated in FIG. **14**, the distribution closure **178** has a case **135** similar to that of the above-mentioned distribution closure **132**, while a plurality of connecting modules **137** (see FIG. **8**(*a*)) are arranged along the width direction of the module storing section **136** of the case **135** as being erected with respect to the bottom face of the closure main body **133**.

Each connecting modules **137** is stored in the module storing section **136** such that the 4-core MT connectors **143** and single-core connectors **144** face the front side of the case **135**. The 4-core coated fiber ribbon **109** is connector-connected to the MT connector **143**, while the coated optical fibers **115** of the branch cable **105** are connector-connected to the respective single-core connectors **144**. As a consequence, the 4-core coated fiber ribbon **109** and each coated optical fiber **115** of the branch cable **105** are connected to each other through the connecting module **137**.

The branch cable **105** and drop cable **103** are branch-connected to each other through a drop closure **154** at a drop point as in the optical interconnection system **101** illustrated in FIG. **1**.

Since the feeder closure **171** is provided with the connector module **172** having an optical branching function, the optical interconnection system **170** can increase the number of branch cables **104** connected to the feeder closure and the number of subscribers connected to an office, thereby enhancing the use efficiency of the system.

[Third Embodiment]

FIG. **15** is a structural view of still another optical interconnection system equipped with the third embodiment of the optical cable connecting closure in accordance with the present invention. In this drawing, the members identical to those in the optical interconnection systems illustrated in FIGS. **1** and **11** will be referred to with the same signs while omitting their explanations.

In the optical interconnection system **180** illustrated in FIG. **15**, a feeder cable **102** and a branch cable **104** are connected to each other through the feeder closure **118** at a feeder point as in the optical interconnection system **101** illustrated in FIG. **1**. The branch cables **104**, **105** are branch-connected through the distribution closure **178** at a distribution point as in the optical interconnection system **170** illustrated in FIG. **11**.

The branch cable **105** and drop cable **103** are branch-connected to each other through a drop closure **181** at a drop point.

As illustrated in FIG. **16**, the drop closure **181** has a case **157** similar to that of the above-mentioned drop closure **154**; one connecting module **182** is stored in the module storing section **159** of the case **157** while being erected with respect to the bottom face of the closure main body **155**. The structure for storing the connecting module **182** in the module storing section **159** is totally the same as the structure for storing the connecting module **158** mentioned above.

As illustrated in FIGS. **16** and **17**, the connecting module **182** has a module main body **183** with the same structure and dimensions as those of the above-mentioned connecting module **158**. A single-core connector **184** is attached to one end face of the module main body **183**, while a plurality of (**8** here) single-core connectors **185** are attached to the other end face of the module main body **183**.

An optical connecting section **186** for connecting the single-core connectors **184**, **185** to each other is arranged within the module main body **183**. The optical connecting section **186** includes an optical splitter **151** (mentioned above) and connects the single-core connectors **184**, **185** to each other with optical branching through optical fibers **187**.

The connecting module **182** may be made as a dedicated module separate from the above-mentioned connecting module **158**, or the single-core connector **184** may be made selectively attachable to both end parts of the module main body **183**, so as to be also usable as the above-mentioned connecting module **158**.

The connecting module **182** is stored in the module storing section **159** such that the single-core connectors **184**, **185** face the left and right sides with respect to the front side of the case **157**. The coated optical fiber **115** of the branch cable **105** is connector-connected to the single-core connector **184**, while the single-core drop cable **103** is connector-connected to each single-core connector **185**. As a consequence, the coated optical fiber **115** of the branch cable **105** and the drop cable **103** are connected to each other through the connecting module **182**.

Since the drop closure **181** is provided with the connecting module **182** having an optical branching function in the optical interconnection system **180**, the system can effectively be utilized without unnecessarily increasing the number of branch cables **104**, **105** in areas where many subscribers' homes are densely packed.

As in the foregoing, a plurality of kinds of connecting modules **123**, **137**, **138**, **158**, **172**, **182** which are different from each other in terms of modes (functions) of connecting optical connectors to each other in the first to third embodiments have module main bodies with the same structure and dimensions. Also, the module storing sections of the cases in the feeder and distribution closures have the same structure. Therefore, the connecting modules **123**, **137**, **138**, **172** can be used for any of the feeder and distribution closures, while the connecting modules **158**, **182** can be used for the drop closure. Hence, even when the optical interconnection system is changed, it is unnecessary to design and manufacture the feeder and distribution closures from scratch in conformity to required connecting functions.

Specifically, when changing the optical interconnection system illustrated in FIG. **1** to that illustrated in FIG. **11**, the 4-core coated fiber ribbons **109** of the feeder cable **102** and the 4-core coated fiber ribbons **109** of the branch cable **104** are removed from the connecting module **123** while the door **120** of the feeder closure **118** is open, and then the connecting module **123** is pulled out of the case **121**. Then, another connecting module **172** is stored into the module storing section **122** of the case **121**, and the 4-core coated fiber ribbon **109** of the feeder cable **102** and the 4-core coated fiber ribbons **109** of the branch cable **104** are connector-connected to the connecting module **172**. This constructs the feeder closure **171** illustrated in FIG. **12**.

While the door **134** of the distribution closure **132** is open, each coated optical fiber **115** of the branch cable **105** is removed from the connecting module **138**, the connecting optical fiber **105** is removed from the connecting modules **137**, **138**, and then the connecting module **138** is pulled out of the case **135**. Thereafter, each coated optical fiber **115** of the branch cable **105** is connector-connected to the connecting module **137**. This constructs the distribution closure **178** illustrated in FIG. **14**.

Similarly, when changing the optical interconnection system illustrated in FIG. **1** to that illustrated in FIG. **15**, the connecting module **138** is pulled out of the case **135** of the distribution closure **132**, and each coated optical fiber **115** of the branch cable **105** is connector-connected to the connecting module **137**, so as to construct the distribution closure **178** illustrated in FIG. **14**.

While the door **156** of the drop closure **154** is open, the coated optical fiber **115** of the branch cable **105** and the drop cable **103** are removed from the connecting module **158**, and then the connecting module **158** is pulled out of the case **157**. Thereafter, another connecting module **182** is stored into the module storing section **159** of the case **157**, and the coated optical fiber **115** of the branch cable **105** and the drop cables **103** are connector-connected to the connecting module **182**. This constructs the drop closure **181** illustrated in FIG. **16**.

Thus, when connecting functions required for the distribution and drop closures are changed, it will be sufficient if other kinds of connecting modules conforming to the changed requirements replace old ones or such kinds of connecting modules are left as they are in a plurality of kinds of connecting modules stored in the case. This can easily cope with future changes in optical interconnection systems.

The present invention is not limited to the above-mentioned first to third embodiments. For example, though the above-mentioned first to third embodiments relate to optical interconnection systems constructed between a transmission apparatus within an office and a plurality of subscribers' homes, the optical cable connecting closure of the present invention is also applicable to other modes of optical interconnection systems as a matter of course.

[Fourth Embodiment]

The optical cable connecting closure in accordance with the fourth embodiment of the present invention will now be explained. FIG. **18** is a broken perspective view illustrating the optical cable connecting closure in accordance with the fourth embodiment of the present invention, while FIG. **19** is a perspective view illustrating a splitter module section in the optical cable connecting closure of FIG. **18**. As illustrated in FIG. **18**, the optical cable connecting closure **201** is used for connecting optical cables. Here, the optical cable connecting closure **201** interconnects a main cable (first optical cable) T**0** for delivering communication information of the Internet and the like with a branch cable (second optical cable) T**1** having a coated optical fiber of several to several ten cores and existing near a dwelling. The optical cable connecting closure **201** has a main body section **202**, a plurality of splitter module sections **203**, and a guide section **204**.

The main body section **202**, which constructs the outer circumference of the optical cable connecting closure **201**, is shaped like an elongated box. The main body section **202** is hermetically sealable with a lid (not depicted) and stores therein the splitter module sections **203** and guide section **204**. The main cable T**0** passes through the upper part of the main body section **202** along a longitudinal direction (hereinafter referred to as "front-to-back direction"). The branch cable T**1** is connected to the rear end part (depicted right side) of the main body section **202**.

Each splitter module section **203** optically splits a coated optical fiber (first coated optical fiber) **206** of the main cable T**0** and connects thus obtained branches to coated optical fibers (second coated optical fibers) **208** of the branch cable T**1**. The splitter module section **203**, which is of a plate-shaped cassette type, is constructed such as to have an optical waveguide therewithin, for example. When seen in the thickness direction, the splitter module section **203** has a rectangular form which is elongated in the front-to-back direction.

Specifically, as illustrated in FIG. **19**, the splitter module section **203** is formed like a rectangle having cut off one corner portion, so that a tilted surface **203***e* inclined with respect to the longitudinal direction is formed on the outer peripheral face. More specifically, the outer peripheral face of the splitter module section **203** comprises end faces **203***a*, **203***b* which are perpendicular to the longitudinal direction, side faces **203***c*, **203***d* which are parallel to the longitudinal direction, and the tilted surface **203***e*, and is constructed such that the side face **203***c* continues with the end faces **203***a*, **203***b* on one end side thereof, the tilted surface **203***e* continues with the end face **203***a* on the other end side, and the side face **203***d* continues with the tilted surface **203***e* and end face **203***b*.

The tilted surface **203***e* of the splitter module section **203** is provided with an input connector (first connector) **205** to which the coated optical fiber **206** of the main cable T**0** is connected. As the coated optical fiber **206**, a 4-core coated fiber ribbon is used. As the input connector **205**, a multicore fiber connecting MT (Mechanically Transferable) connector is used, for example.

The end face **203***b* of the splitter module section **203** is provided with a plurality of output connectors (second connectors) **207** to which the coated optical fibers **208** of the branch cable T**1** are connected. Here, four output connectors **207** are arranged in a row along the width direction of the splitter module section **203**. Each of the output connectors **207** is connectable to two coated optical fibers **208**. Hence, eight coated optical fibers **208** can be connected to the splitter module section **203**. As the coated optical fiber **208**, a 4-core coated fiber ribbon is used. For example, a multicore fiber connecting MT connector is used as the output connector **207**. The coated optical fiber **208** is protected by an ID tube (not depicted) for identifying and protecting the coated optical fiber.

An engagement groove **209** for engaging a rotary shaft G is provided in the side face **203***c* of the splitter module section **203** at an end part nearer to the input connector **205**.

Returning to FIG. **18**, the splitter module sections **203** are arranged within the main body section **202** such that the input connectors **205** are positioned on the front side (the output connectors **207** are on the rear side). Six splitter module sections **203** are stacked in a vertical row, while their engagement grooves **209** engage the rotary shaft G (see FIG. **19**) passing therethrough. This makes each splitter module section **203** rotatable by a predetermined angular range (range of 0° to 90° here) in directions of arrow a. Hence, the splitter module sections **203** are constructed such as to be rotatable about the axis of the rotary shaft G provided near the input connectors **205**.

The guide section **204**, which is used for guiding the coated optical fibers **208**, is provided behind the splitter module sections **203** within the main body section **202**. The guide section **204** has comb-toothed pieces **204***a*, each extending in the width direction of the main body section **202**, arranged in a vertical row. Hence, the guide section **204** is shaped like comb teeth.

Specifically, the comb-toothed pieces **204***a* are arranged in a vertical row with predetermined intervals corresponding to the respective thicknesses of the stacked splitter modules **203**. This allows the coated optical fibers **208** connected to each splitter module **203** to advance through their corresponding gap between the comb-toothed pieces **204***a*, thereby preventing the coated optical fibers **208** from causing congestion.

In an optical cable connecting closure in the conventional FTTH, the main body section **202** typically stores therein a fusion welding section (termination board or the like), through which the coated optical fibers **206**, **208** are connected to the splitter module sections **203**. Therefore, an extra coated fiber length of about 1 m is necessary for fusion splicing within the main body section **202** from the viewpoint of estimating 5 to 10 times of splicing failures and securing the working distance to a fusion splicer. This increases the extra length of coated optical fibers, thereby making it cumbersome to handle the coated optical fibers.

As the extra length of coated optical fibers is longer, the storage time for storing (accommodating) the coated optical fibers **206**, **208** in the main body section **202** increases. A splicing time of about 3 to 5 min is necessary for splicing by the fusion splicer. Therefore, fear of causing troubles becomes remarkable in an operation for opening an optical line having an enormous number of coated fibers.

In the optical cable connecting closure **201** of the fourth embodiment, by contrast, the coated optical fibers **206** are directly connected to the input connectors **205**, while the coated optical fibers **208** are directly connected to the output connectors **207**, so that the coated optical fibers **206**, **208** can be restrained from increasing their extra length, whereby the extra length of coated fibers can be shortened. As a result, it becomes easier to handle the coated optical fibers **206**, **208**, whereby the working efficiency in connecting or storing the coated optical fibers **206**, **208** can be improved. Further, it reduces cumbersome operations such as the processing of the extra length of coated fibers, thereby making it possible to inhibit the quality from being adversely affected by contact with the coated optical fibers **206**, **208** and shorten the operation time.

In the optical cable connecting closure **201**, the splitter module sections **203** are constructed such as to be rotatable about the rotary axis G provided near the input connectors **205** as mentioned above. Therefore, the splitter module sections **203** can be rotated as desired when attaching/removing the coated optical fibers **208** to/from the output connectors **207**, so as to locate the output connectors **207** at positions where the coated optical fibers **208** are easy to attach/remove. As a result, the detachability of the coated optical fibers **208** can be improved.

When storing the coated optical fibers **208** after attaching and removing them, the positions of the splitter module sections **203** can be rotated again, so as to store the coated optical fibers **208** with a high density within the main body section **202**. Since each splitter module **203** is provided with a plurality of output connectors **207** to which the coated optical fibers **208** are connected, the effect of improving the detachability of the coated optical fibers **208** is effective in particular.

In the optical cable connecting closure **201**, the splitter module sections **203** are arranged so as to be stacked within the main body section **202** as mentioned above and thus can favorably be stored in a smaller space within the main body section **202**.

Since the optical cable connecting closure **201** is equipped with the guide section **204** formed like comb teeth, the coated optical fibers **208** can advance through gaps (groove parts) between its comb-toothed pieces **204***a*, thereby preventing the coated optical fibers **208** from causing congestion, and smoothly follow movements of the splitter module sections **203**. Since the comb-toothed pieces **204***a* are placed at predetermined intervals corresponding to the respective thicknesses of the stacked splitter module sections **203**, the coated optical fibers **208** can be divided into the respective groups connected to the splitter module sections **203**.

In the optical cable connecting closure **201**, the splitter module sections **203** can be attached to or removed from the main body section **202** by inserting or removing the connectors **205**, **207** and thus can easily be replaced easily with splitter module sections having different functions, for example. As a result, in the case where a nearby wiring network is changed after installing the optical cable connecting closure **201**, for example, functions of module sections can easily be replaced partly, whereby it becomes unnecessary to newly provide another closure.

Since the input connector **205** is provided on the tilted surface **203***e* in the splitter module section **203** as mentioned above, the coated optical fiber **206** can easily be connected to the input connector **205**. Since the input connector **205** is positioned on the front side of the main body section **202**, while the output connectors **207** are positioned on the rear side, the coated optical fibers **206**, **208** within the main body section **202** are further prevented from causing congestion.

[Fifth Embodiment]

The optical cable connecting closure **210** in accordance with the fifth embodiment of the present invention will now be explained. In the following explanations, differences from the above-mentioned fourth embodiment will mainly be set forth while omitting descriptions similar thereto.

FIG. **20** is a broken perspective view illustrating the optical cable connecting closure in accordance with the fifth embodiment of the present invention. As illustrated in FIG. **20**, the optical cable connecting closure **210** interconnects a main cable T**0** with a branch cable (second optical cable) T**2** constituted by a plurality of drop cables (second coated optical fibers) **218**. Each drop cable **218** is a single-core coated optical fiber, which is often used for leading a coated optical fiber into a dwelling. The optical cable connecting closure **210** differs from the above-mentioned optical cable connecting closure **201** in that branching coated fiber module sections **213** are provided in place of the splitter module sections **203**.

The branching coated fiber module sections **213** connect the coated optical fibers **206** of the main cable T**0** to the drop cables **218** of the branch cable T**2** through multicore/single-core conversion. The branching coated fiber module sections **213** have outer forms similar to those of the above-mentioned splitter module sections **203**. A plurality of output connectors (second connectors) **217** are provided at the rear end face **213***b* of each branching coated fiber module section **213**. Here, four output connectors are arranged in a row along the width direction of the branching coated fiber module section **213**. As the output connector **217**, a sheath holding connector is used.

This optical cable connecting closure **210** also yields an effect similar to that of the above-mentioned optical cable connecting closure **201**, i.e., the effect that the coated fiber extra length can be shortened.

Since the above-mentioned splitter module section **203** and branching coated fiber module section **213** have outer forms identical to each other, the module sections **203**, **213** are compatible with each other, whereby one used as the branching coated fiber module section **213** may be exchanged for the splitter module section **203** or vice versa, for example. Therefore, the coated optical fibers **206**, **208**, **218** can be interconnected freely within the main body section **202**.

Since the sheath holding connector is used as the output connected **217** as mentioned above, the drop cable **218** can directly be connected to the output connector **217** in a favorable manner. That is, even the drop cables **218** laid aerially within the main body section **202** can be prevented from being contacted and causing quality failures.

Though preferred embodiments of the present invention are explained in the foregoing, the present invention is not limited to the above-mentioned fourth and fifth embodiments. For example, the optical cable connecting closure may have both of the splitter module section **203** and branching coated fiber module section **213**.

Specifically, as illustrated in FIG. **21**(*a*), an optical cable connecting closure **230** may comprise module sections **203**, **213**. The module sections **203**, **213** are provided within the main body section **202** so as to be stacked in a vertical row. Specifically, three splitter module sections **203** are stacked on the upper side of three branching coated fiber module sections **213**. In this optical cable connecting closure **230**, a coated optical fiber **208** connected to an output connector **207** of a splitter module section **203** is connected to an input connector **205** of a branching coated fiber module section **213**. Hence, the coated optical fiber **208** constitutes a third coated optical fiber, while the output connector **207** of the splitter module section **203** and the input connector **205** of the branching coated fiber module section **213** constitute third connectors.

As illustrated in FIG. **21**(*b*), an optical cable connecting closure **240** may comprise splitter module sections **203** stacked in a vertical row on the front side of the main body section **202** and branching coated fiber module sections **213** stacked in a vertical row on the rear side of the main body section **202**. In this optical cable connecting closure **240**, respective guide sections **204** are provided behind the module sections **203**, **213**. In this optical cable connecting closure **240**, a coated optical fibers **208** connected to an output connector **207** of a splitter module section **203** is connected to an input connector **205** of a branching coated fiber module section **213**. Hence, the coated optical fiber **208** constitutes a third coated optical fiber, while the output connector **207** of the splitter module section **203** and the input connector **205** of the branching coated fiber module section **213** constitute third connectors.

In these optical cable connecting closures **230**, **240**, a coated optical fiber **206** is directly connected to an input connector **205** of a splitter module section **203**, while a drop cable **218** is directly connected to an output connector **217** of a branching coated fiber module section **213**. The coated optical fiber **208** is directly connected to an output connector **207** of the splitter module section **203** and the input connector **205** of the branching coated fiber module section **213**. This yields the effect of making it possible to shorten the coated fiber extra length as with the above.

Since the main body section **202** is shared by the splitter module sections **203** and branching coated fiber module sections **213**, it is not necessary to provide two kinds of main body sections **202** corresponding to them in the optical cable connecting closures **230**, **240**.

In the optical cable connecting closures **230**, **240**, a coated optical fiber **206** may be connected to an input connector **205** of the branching coated fiber module section **213**, a drop cable **218** may be connected to an output connector **207** of a splitter module section **203**, and a coated optical fiber **208** may be connected to an output connector **217** of the branching coated fiber module section **213** and an input connector **205** of the splitter module section **203**. In this case, the coated optical fiber **208** constitutes a third coated optical fiber, while the input connector **205** of the splitter module section **203** and the output connector **217** of the branching coated fiber module section **213** constitute third connectors.

[Sixth Embodiment]

The sixth embodiment of the present invention will now be explained. The sixth embodiment of the present invention relates to a terminating structure for an aggregate drop cable in which a plurality of drop cables are stranded together and a closure employing this structure.

First, the background art in the sixth embodiment of the present invention will be explained. Known as a method of constructing a network by optical fiber cables is one installing closures for storing connecting sections of optical fibers in three stages of a feeder point, a distribution point, and a division point from a base station to a subscriber's home and selectively storing optical fiber cables in the respective closures at the installation points in order to attain rational connections in the respective stages.

For example, a multicore slotted ribbon cable is typically stored as a branch line in a closure at the feeder point positioned on the base station side. A closure at the division point containing a drop line to a subscriber's home stores an appropriate number of drop cables each including a single- or

2-core optical fiber as the drop line. On the other hand, in order to save labor of wiring drop lines, it has been becoming widespread to utilize an aggregate drop cable having a structure in which a plurality of drop cables are stranded together as a sub-branch line in optical fiber cables for connecting the closure at the distribution point to the closure at the division point.

FIGS. **28** and **29** illustrate structural examples of aggregate drop cables used as a sub-branch line between a distribution point and a drop point. The aggregate drop cable **311** illustrated in FIG. **28** has a structure in which four single-core cables **313** (single-core elements) are stranded about a support wire **312**. Each single-core drop cable **313** has a structure in which one optical fiber **314** and two tension members **315** flanking the optical fiber **314** on both sides are covered with a coating **316**. The aggregate drop cable **317** illustrated in FIG. **29** has a structure in which a circular bundle constituted by a greater number of single-core drop cables **313** stranded together is longitudinally supported by a support wire **318**, while a bind wire **319** binds the bundle of single-core drop cables **313** and the support wire **318** together.

When introducing/removing such drop cable **311** or **317** into/from a closure, the stranded single-core drop cables **313** have conventionally been untied, so as to be inserted or held one by one at a cable leading-in/out section of the closure.

FIG. **30** illustrates the structure of a cable leading-in/out section at an end part of a conventional closure. The cable leading-in/out section **341** illustrated here, which is disclosed in Japanese Patent Application Laid-Open No. 2005-295749, is constituted by a sealing end face plate **371** for hermetically closing an opening part at each end of a cylindrical case of the closure, and a cable holding device **373** provided near the end face plate **371** within the case main body of the closure.

As also illustrated in FIG. **31**, the end face plate **371** is formed with a cable inserting section **363** for inserting a main cable **303** therethrough, two cable inserting sections **365** for inserting branch cables **305** therethrough, and a plurality of cable inserting sections **367** for inserting respective drop cables **307** therethrough. Each of the cable inserting sections **363**, **365** is constructed so as to be able to open by being divided into two as illustrated in FIG. **32** in order for cables to be simply inserted therethrough by wedging.

As illustrated in FIG. **30**, the cable holding device **373** is constituted by a device main body **374** secured to the case main body of the closure, insert nuts **343** screwed to the device main body **374** in order to hold the cables **303**, **305**, and position regulating plates **375** secured to the device main body **374** in order to hold the drop cables **307**.

A pair of insert nuts **343** are arranged at each of positions corresponding to the cable inserting sections **363**, **365**, **365** and hold the cable **303**, **305** inserted through the cable inserting section **363**, **365**, **365** with a pair of insert clasps.

Each of the position regulating plates **375**, which is a resin molded product, is formed with a plurality of cable holding grooves **389**, at predetermined intervals, for holding the drop cables **307** and keeps a plurality of drop cables **307** in an aligned state by individually wedging the drop cables **307** inserted through the cable inserting sections **367** into the respective cable holding grooves **389** one by one.

A problem of the above-mentioned background art and an object of the sixth embodiment will now be explained. The operation of untying the single-core drop cables **313** constituting the aggregate drop cables **311**, **317** illustrated in FIGS. **28** and **29**, inserting them one by one through the cable inserting sections **367** of the sealing end face plate **371** illustrated in FIG. **30**, and wedging them into the cable holding grooves **389** for drop cables in the cable holding device **373** one by one, for example, takes much labor, thereby consuming time.

Besides, the number of cable inserting sections **367** or cable holding grooves **389** for drop cables provided in the cable leading-in/out section **341** in the existing closure is about 12 to 16 at the maximum, so that a multistart aggregate drop cable **317** in which 16 or more drop cables are stranded cannot be stored in the existing closure **351**.

The object of the sixth embodiment of the present invention is to overcome the problem mentioned above and provide a terminating structure for an aggregate drop cable which makes it unnecessary to insert drop cables one by one through the cable inserting sections or holding grooves for drop cables when leading the aggregate drop cables into and out of the closure, so as to be able to improve the workability, and allows the existing closure to store even a multistart drop cable including drop cables having a number exceeding the number of drop cables expected to be stored in the existing closure, and a closure employing this structure.

Means provided in the sixth embodiment of the present invention for overcoming the above-mentioned problem and achieving the above-mentioned object will now be explained.

(1) For overcoming the above-mentioned problem, the terminating structure for an aggregate drop cable in accordance with the sixth embodiment is a terminating structure for an aggregate drop cable constituted by stranding a plurality of drop cables, the structure comprising a waterproof binding section bundled with a waterproof tape wrapped about an area held with a sealing end face plate of a closure and a holding binding section bundled with a holding tape wrapped about an area held with a cable holding device; wherein, after the plurality of drop cables are arranged on the waterproof tape or holding tape, the waterproof binding section and holding binding section are wound together with the tape from one end side of the tape, so as to be finished as a substantially circular bundle having the plurality of drop cables arranged spirally.

(2) The above-mentioned terminating structure for an aggregate drop cable may be characterized in that at least a surface of the waterproof tape is formed by a thermoplastic elastomer having a low degree of hardness and an elasticity.

(3) The above-mentioned terminating structure for an aggregate drop cable may be characterized in that a surface of the holding tape is formed with an antiskid part for restraining a member in contact with the surface from moving.

(4) For overcoming the above-mentioned problem and achieving the above-mentioned object, the closure in accordance with the sixth embodiment is a closure, having the terminating structure for an aggregate drop cable according to any of the above-mentioned (1) to (3), for leading the drop cable in and out, the closure comprising, as a cable leading-in/out section for inserting therethrough the aggregate drop cable, a sealing end face plate for inserting the waterproof binding section and a cable holding device for holding the holding binding section.

In this terminating structure for an aggregate drop cable, the spirally wound waterproof tape fills and seals gaps between drop cables which are adjacent to each other in a radial direction of the spiral, so that the waterproof binding section at an end part of the aggregate drop cable does not lose its waterproofness at the cable inserting sections even when collectively inserted therethrough as a single waterproof cable having a large diameter in a bundled state.

The spirally wound holding tape is interposed between drop cables which are adjacent to each other in a radial direction of the spiral, so that the holding binding section at an end part of the aggregate drop cable is bound like a multicore cable in which the adjacent drop cables are kept from relatively slipping with respect to each other, and thus can favorably hold and secure all the drop cables even when collectively held as a single cable having a large diameter in a bundled state by the cable holding device.

By assigning a cable inserting section for a main cable or branch cable to a cable inserting section for inserting therethrough the waterproof binding section of an aggregate drop cable and a cable holding device for a main cable or branch cable to a cable holding device for holding the holding binding section, for example, the closure in accordance with the sixth embodiment can store a multistart aggregate drop cable without modifying the existing sealing end face plate or cable holding device and taking labor.

The terminating structure for an aggregate drop cable in accordance with the sixth embodiment of the present invention will now be explained in detail with reference to the drawings.

FIG. **22** is a front view of a mode for carrying out a closure for leading in and out the aggregate drop cable in the terminating structure in accordance with the sixth embodiment, FIG. **23** is a perspective view illustrating a structure for holding the aggregate drop cable in the cable leading-in/out section of the closure illustrated in FIG. **22**, FIG. **24** is a perspective view of the terminating structure for the aggregate drop cable inserted into the cable leading-in/out section illustrated in FIG. **23**, and FIG. **25** is a sectional view taken along the line B-B of FIG. **24**.

The closure **351** illustrated in FIG. **22**, which is installed at a so-called distribution point of an optical cable network and stores and protects an optical cable connecting section **309** for connecting a branch cable or aggregated drop cable **306** as a sub-branch line to a main cable **303** such as a multicore slotted ribbon cable, and is constituted by a cylindrical case **353** surrounding the outer periphery of the optical cable connecting section **309** and cable leading-in/out sections **341** provided in opening parts **353***a*, **353***b* at both ends of the cylindrical case **353** through which the cables **303**, **306** are let in and out.

Utilized as the aggregate drop cable **306** is one obtained by subjecting any of the aggregate drop cables **311**, **317** illustrated in FIGS. **28** and **29** and the like to a terminating process which will be explained later.

As mentioned above, the cylindrical case **353** is one forming a cylindrical structure opening at both ends by a case main body **354** storing the optical cable connecting section **309** and opening the front face and a cover **355** covering the open face of the case main body **354**. In the illustrated example, the cover **355** has one side edge **355***a* hinged to the case main body **354** so as to be openable and closable. The other side edge **355***b* of the cover **355** is provided with an elastic stopper **355***c* adapted to engage an engagement section on the case main body **354** side when the cover **355** is closed.

The cable leading-in/out section **341** comprises sealing end face plates **371** which hermetically close opening parts **353***a*, **353***b* at both ends of the cylindrical case **353** and are formed with cable inserting sections **363**, **365**, **367**, and cable holding devices **373** which hold and secure the cables **303**, **306** and single-core drop cables inserted through the cable inserting sections **363**, **365**, **367**.

As illustrated in FIG. **23**, the sealing end face plate **371** comprises an outer shell base **377** which is formed by a hard resin, metal, or the like and defines an outer shell form, and sealing plates **379**, **380**, **381** made of a rubber which are attached to the inner peripheral part of the outer shell base **377** and provide the respective cable inserting sections **363**, **365**, **367**.

The sealing end face plate **371** has the same structure as that illustrated in FIGS. **30** to **32**. The cable inserting section **363** formed in the sealing plate **379** made of a rubber is a hole for inserting therethrough the main cable **303**, the cable inserting section **365** is a hole for inserting therethrough the branch cable **305** (see FIG. **30**) or the aggregate drop cable **306**, and the cable inserting sections **367** are holes for inserting therethrough the respective single-core drop cables **307** one by one. Each of the cable inserting sections **363**, **365** is constructed so as to be able to open by being divided into two as illustrated in FIG. **32** in order for cables to be simply inserted therethrough by wedging.

As illustrated in FIG. **23**, the cable holding device **373** is constituted by a device main body **374** secured to the case main body **354**, insert nuts **343** screwed to the device main body **374** in order to hold the cables **303**, **305**, **306**, and position regulating plates **375** secured to the device main body **374** in order to hold the single-core drop cables **307**.

A pair of insert nuts **343** are arranged at each of positions corresponding to the cable inserting sections **363**, **365** and hold and secure the cable **303**, **305**, **306** inserted through the cable inserting section **363**, **365** by clasping.

Each of the position regulating plates **375**, which is a resin molded product, is formed with a plurality of cable holding grooves **389**, at predetermined intervals, for holding the drop cables **307** and is constructed such as to hold a plurality of drop cables **307** in an aligned state by individually wedging the drop cables **307** inserted through the cable inserting sections **367** into the respective cable holding grooves **389** one by one. However, this embodiment uses no single-core drop cables **307** and thus does not utilize the position regulating plates **375**.

In the closure **351** of this embodiment, as illustrated in FIG. **23**, the aggregate drop cable **306** is inserted through the cable inserting section **365** for the branch cable **305** having a hole diameter corresponding to the outer diameter of the aggregate drop cable **306** and secured by clasping with a pair of insert nuts **343** corresponding to the cable inserting section **365**.

As illustrated in FIG. **24**, at an end part of the aggregate drop cable **306**, a waterproof binding section **323** is formed by wrapping a waterproof tape **321** about a bundle of all the single-core drop cables **313** constituting the cable in an area to be held with the sealing end face plate **371** of the cable leading-in/out section **341** in the closure **351**. A holding binding section **327** is formed by wrapping a holding tape **325** about a bundle of all the single-core drop cables **313** constituting the cable in an area to be held with the cable holding device **373** of the cable leading-in/out section **341**.

A plurality of untied drop cables **313** are arranged in a row on the waterproof tape **321** or holding tape **325** as illustrated in FIG. **25**, and then are wound together with the tape **321**, **325** from one end side thereof as illustrated in FIG. **26**, whereby the waterproof binding section **323** and holding binding section **327** are finished as a substantially cylindrical bundle in which a plurality of drop cables **313** are arranged spirally.

For filling the gaps between the drop cables **313** arranged on the surface, at least a surface of the waterproof tape **321** is formed from a thermoplastic elastomer (SEBS copolymer) having a low degree of hardness and an elasticity. The thickness of the waterproof tape **321** is set to about 1 to 2 mm.

The holding tape **325** is formed by extruding a resin material such as polyethylene or polypropylene into a tape shape and has a surface formed with wavy or irregular antiskid parts for restraining the drop cables **313** from coming into contact with the surface. The thickness of the waterproof tape **325** is set to about 1 to 2 mm.

The antiskid parts are those roughening the surface with the above-mentioned irregularities, for example, by embossing the surface at the time of extruding the resin. A metal tape may also be used as the holding tape **325**. Antiskid irregularities and the like for restraining the movement of contactable members are also formed by embossing the surface in this case.

In the terminating structure for the aggregate drop cable **306** explained in the foregoing, the elastomer layer of the spirally wound waterproof tape **321** fills the gaps between the drop cables **313** adjacent to each other in the radial direction of the spiral, thereby sealing the gaps in the drop cables **313** adjacent to each other in the radial and circumferential directions, whereby the waterproof binding section **323** at the end part of the aggregate drop cable **306** does not lose waterproofness at the cable inserting section **365** even when collectively inserted therethrough as a single waterproof cable having a large diameter in a bundled state.

Since the spirally wound holding tape **325** is interposed between the drop cables **313** adjacent to each other in the radial direction of the spiral and binds them as a multicore cable in which the adjacent drop cables **313** are kept from slipping with respect to each other, the holding binding section **327** of the aggregate drop cable **306** can favorably hold and secure all the drop cables **313** even when they are collectively clasped as a single cable in a bundled state having a large diameter by a pair of insert nuts **343**.

Therefore, when inserting the aggregate drop cable **306** through the cable leading-in/out section **341** of the closure **351**, the terminating structure for the aggregate drop cable **306** in accordance with the sixth embodiment can lead the cable in a bundled state into and out of the closure **351**, for example, by using the cable inserting section **365** for branch cables and the insert nuts **343** as illustrated in FIG. **23** without using the dedicated cable inserting sections **367** for inserting the drop cables one by one, thereby making it possible to reduce the labor of storing it into the closure **351** and improve the workability. Even a multistart drop cable including drop cables whose number exceeds the number of those estimated to be storable in the existing closure **351** can be stored therein.

Since the waterproof tape **321** used for forming the waterproof binding section **323** has a surface formed by a thermoplastic elastomer having a low degree of hardness and an elasticity, the single-core drop cables **313** in contact with the tape surface bite into the surface because of its elastic deformation, so that the gaps between the adjacent drop cables **313** are filled, which makes it possible to attain favorable waterproofness.

The holding tape **325** used for forming the holding binding section **327** has a surface formed with antiskid parts, so that slippage is harder to occur when held by the insert nuts **343**, which makes it easier to hold.

By assigning the cable inserting section **365** for branch cables to the cable inserting section for inserting the waterproof binding section **323** of the aggregate drop cable **306** therethrough and the insert nuts **343**, which are cable holding devices for branch cables, to the cable holding devices for holding the holding binding section **327** of the aggregate drop cable **306**, the closure **351** employing the terminating structure of this embodiment is applicable to the multistart aggregate drop cable **306** without modifying the existing sealing end face plate **371** and cable holding device **373** and taking labor.

The terminated aggregate drop cable **306** is inserted through the cable inserting section **365** for the branch cable **305** in the above-mentioned embodiment, but may be inserted through the cable inserting section **363** for the main cable **303**.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a structural view illustrating an optical interconnection system equipped with the first embodiment of the optical cable connecting closure in accordance with the present invention;

FIG. **2** is an enlarged sectional view of the feeder cable and branch cable illustrated in FIG. **1**;

FIG. **3** is an enlarged sectional view of the drop cable illustrated in FIG. **1**;

FIG. **4** is an enlarged sectional view of the sub-branch cable illustrated in FIG. **1**;

FIG. **5** is a perspective view of the feeder closure illustrated in FIG. **1** in its open state;

FIG. **6** is a schematic plan view of the connecting module illustrated in FIG. **5**;

FIG. **7** is a perspective view of the distribution closure illustrated in FIG. **1** in its open state;

FIGS. **8***a* and **8***b* are a schematic plan view of each connecting module illustrated in FIG. **7**;

FIG. **9** is a perspective view of the drop closure illustrated in FIG. **1** in its open state;

FIG. **10** is a schematic plan view of the connecting module illustrated in FIG. **9**;

FIG. **11** is a structural view illustrating another optical interconnection system equipped with the second embodiment of the optical cable connecting closure in accordance with the present invention;

FIG. **12** is a perspective view of the feeder closure illustrated in FIG. **11** in its open state;

FIG. **13** is a schematic plan view of the connecting module illustrated in FIG. **12**;

FIG. **14** is a perspective view of the distribution closure illustrated in FIG. **11** in its open state;

FIG. **15** is a structural view illustrating still another optical interconnection system equipped with the third embodiment of the optical cable connecting closure in accordance with the present invention;

FIG. **16** is a perspective view of the drop closure illustrated in FIG. **15** in its open state;

FIG. **17** is a schematic plan view of the connecting module illustrated in FIG. **16**;

FIG. **18** is a sectional perspective view illustrating the optical cable connecting closure in accordance with the fourth embodiment of the present invention;

FIG. **19** is a perspective view illustrating a module section of the optical cable connecting closure in FIG. **18**;

FIG. **20** is a sectional perspective view illustrating the optical cable connecting closure in accordance with the fifth embodiment of the present invention;

FIG. **21** is a sectional view illustrating the optical cable connecting closure in accordance with a modified example of the fourth and fifth embodiments of the present invention;

FIG. **22** is a front view of a mode for carrying out a closure for leading in and out the aggregate drop cable in the terminating structure in accordance with the sixth embodiment of the present invention;

FIG. **23** is a perspective view illustrating a structure for holding the aggregate drop cable in the cable leading-in/out section of the closure illustrated in FIG. **22**;

FIG. **24** is a perspective view of the terminating structure for the aggregate drop cable inserted into the cable leading-in/out section illustrated in FIG. **23**;

FIG. **25** is an explanatory view of a method of forming the waterproof binding section and holding binding section illustrated in FIG. **24**;

FIG. **26** is a sectional view of a state where a tape begins to wind spirally from the state illustrated in FIG. **25**;

FIG. **27** is a sectional view taken along the line B-B of FIG. **24**;

FIG. **28** is a perspective view of an example of the aggregate drop cable in the sixth embodiment;

FIG. **29** is a perspective view of another example of the aggregate drop cable in the sixth embodiment;

FIG. **30** is a perspective view illustrating the structure of a cable leading-in/out section in a conventional closure;

FIG. **31** is a front view of the sealing end face plate illustrated in FIG. **30**; and

FIG. **32** is a front view of the sealing end face plate **371** illustrated in FIG. **31** in the state where the cable inserting sections for the main and branch cables are open.

REFERENCE SIGNS LIST

101 . . . optical interconnection system; **102** . . . feeder cable (office-side optical cable); **103** . . . drop cable (subscriber-side optical cable); **104** . . . branch cable (first optical cable); **105** . . . sub-branch cable (second optical cable); **109** . . . 4-core coated optical fiber ribbon (first or second optical fiber); **115** . . . coated optical fiber (first or second optical fiber); **118** . . . feeder closure (office-side closure or optical cable connecting closure); **121** . . . case; **122** . . . module storing section; **123** . . . connecting module; **127** . . . module main body; **128** . . . MT connector (first connector); **129** . . . MT connector (second connector); **130** . . . optical connecting section; **132** . . . distribution closure (intermediate closure or optical cable connecting closure); **135** . . . case; **136** . . . module storing section; **137** . . . connecting module; **138** . . . connecting module; **142** . . . module main body; **143** . . . MT connector (first connector); **144** . . . single-core connector (second connector); **145** . . . optical connecting section; **147** . . . module main body; **148** . . . single-core connector (first connector); **149** . . . single-core connector (second connector); **150** . . . optical connecting section; **151** . . . optical splitter; **153** . . . connecting optical fiber (first or second optical fiber); **154** . . . drop closure (subscriber-side closure or optical cable connecting closure); **157** . . . case; **158** . . . connecting module; **159** . . . module storing section; **163** . . . module main body; **164** . . . single-core connector (first connector); **165** . . . single-core connector (second connector); **167** . . . optical connecting section; **170** . . . optical interconnection system; **171** . . . feeder closure (office-side closure or optical cable connecting closure); **172** . . . connecting module; **173** . . . module main body; **174** . . . MT connector (first connector); **175** . . . MT connector (second connector); **176** . . . optical connecting section; **178** . . . distribution closure (intermediate closure or optical cable connecting closure); **180** . . . optical interconnection system; **181** . . . drop closure (subscriber-side closure or optical cable connecting closure); **182** . . . connecting module; **183** . . . module main body; **184** . . . single-core connector (first connector); **185** . . . single-core connector (second connector); **186** . . . optical connecting section

201, **210**, **230**, **240** . . . optical cable connecting closure; **202** . . . main body section; **203** . . . splitter module section; **204** . . . guide section; **205** . . . input connector (first or third connector); **206** . . . coated optical fiber (first coated optical fiber); **207** . . . output connector (second or third connector); **217** . . . output connector (second connector); **208** . . . coated optical fiber (second or third coated optical fiber); **213** . . . branching coated fiber module section; **218** . . . drop cable (second coated optical fiber); G . . . rotary shaft; T**0** . . . main cable (first optical cable); T**1**, T**2** . . . branch cable (second optical cable)

303 . . . main cable; **305** . . . branch cable; **306** . . . aggregate drop cable; **311** . . . aggregate drop cable; **312** . . . support wire; **313** . . . single-core drop cable; **317** . . . aggregate drop cable; **319** . . . bind wire; **321** . . . waterproof tape; **323** . . . waterproof binding section; **325** . . . holding tape; **327** . . . holding binding section; **341** . . . cable leading-in/out section; **343** . . . insert nut; **363**, **365**, **367** . . . cable inserting section; **371** . . . sealing end face plate; **373** . . . cable holding device; **379**, **380**, **381** . . . sealing plate

The invention claimed is:

1. An optical cable connecting closure comprising:

a case having a module storing section; and

a connecting module, stored in the module storing section so as to be freely insertable therein and removable therefrom, for connecting first and second optical fibers to each other;

wherein the connecting module has a module main body, first and second connectors attached to the module main body and respectively connected to the first and second optical fibers, and an optical connecting section, provided in the module main body, for connecting the first and second connectors to each other;

wherein the module storing section is constructed such as to be able to store a plurality of kinds of connecting modules having the same module main body structure and different connecting functions in optical connecting sections;

wherein a plurality of the connecting modules are stored in the module storing section;

wherein at least two of the connecting modules are connected in order; and

wherein the first and second connectors are provided at an end part of the module main body.

2. An optical cable connecting closure according to claim **1**, wherein the optical connecting section is configured for at least one of the following: straightly connecting the first and second connectors to each other, connecting the first and second connectors to each other with a core number conversion, and connecting the first and second connectors to each other with optical branching.

3. An optical cable connecting closure according to claim **1**, wherein the module storing section has a structure for storing the connecting module vertically with respect to the case such that the first and second connectors face the front side of the case.

4. An optical cable connecting closure according to claim **1**, wherein the first connector is provided at one end part of the module main body, while the second connector is provided at the other end part of the module main body; and

wherein the module storing section has such a structure as to store the connecting module vertically with respect to the case such that the first and second connectors face left and right sides with respect to the front side of the case.

5. An optical interconnection system for aerial optical interconnection between an office-side optical cable and a subscriber-side optical cable, the system comprising:

a first optical cable connected to the office-side optical cable;

a second optical cable connected to the subscriber-side optical cable;

an office-side closure connecting the office-side optical cable and the first optical cable to each other;

a subscriber-side closure for connecting the subscriber-side optical cable and the second optical cable to each other; and

an intermediate closure for connecting the first and second optical cables to each other;

wherein the office-side closure, subscriber-side closure, and intermediate closure are each constituted by the optical cable connecting closure according to claim **1** and have respective kinds of connecting modules different from each other.

6. An optical cable connecting closure used for connecting a first coated optical fiber in a first optical cable and a second coated optical fiber in a second optical cable to each other, the optical cable connecting closure comprising:

a splitter module section for optically splitting;

a branching coated fiber module section for multicore/single-core-converting; and

a main body section for storing the module section,

wherein the module section is provided with a first connector for connecting with the first coated optical fiber and a second connector for connecting with the second coated optical fiber,

wherein the first coated optical fiber, the second coated optical fiber, the splitter module section, and the branching coated fiber module section are connected in the order of the first coated optical fiber, then the first connector, then the branching coated fiber module section, then the splitter module section, then the second connector and then the second coated optical fiber.

7. An optical cable connecting closure according to claim **6**, wherein the splitter module section and branching coated fiber module section have respective outer forms identical to each other.

8. An optical cable connecting closure according to claim **6**, wherein the module section is arranged so as to be stacked.

9. An optical cable connecting closure according to claim **6**, wherein the module section is arranged so as to be rotatable about a rotary axis provided near the first connector.

10. An optical cable connecting closure according to claim **6**, further comprising a comb-toothed guide section, provided within the main body section, for guiding the second coated optical fiber.

11. An optical cable connecting closure used for connecting a first coated optical fiber in a first optical cable and a second coated optical fiber in a second optical cable to each other, the optical cable connecting closure comprising:

a splitter module section for optically splitting;

a branching coated fiber module section for multicore/single-core-converting; and

a main body section for storing the module sections,

wherein the branching coated fiber module section is provided with a first connector for connecting with the first coated optical fiber,

wherein the splitter module section is provided with a second connector for connecting with the second coated optical fiber,

wherein each of the splitter module section and branching coated fiber module section is provided with a third connector for connecting with a third coated optical fiber for connecting the splitter module section and branching coated fiber module section to each other, and

wherein the first coated optical fiber, the second coated optical fiber, the third coated optical fiber, the splitter module section and the branching coated fiber module section are connected in the order of the first coated optical fiber, then the first connector, then the branching coated fiber module section, then the third connector, then the third coated optical fiber, then the third connector, then the splitter module section, then the second connector and then the second coated optical fiber.

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